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ABSTRACT

Telemedicine, the use of bidirectional telecommunications systems for the delivery of health care at a distance, could create a more equitable distribution of medical care. Many medical tasks can be performed at a distance although some require the presence of a physician's assistant. Cost-benefit analysis of this service is difficult and requires further study. The legal issues involved and the psychological effect of telecommunication must also be considered in planning telemedicine programs. Potential future impacts of telemedicine are identified along with recommendations for future research activity and regulation in this field. (Author/PF)

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TELEMEDICINE:
THE ASSESSMENT OF AN EVOLVING HEALTH CARE TECHNOLOGY

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TELEMEDICINE:
THE ASSESSMENT OF AN
EVOLVING HEALTH CARE TECHNOLOGY

ABSTRACT

Telemedicine, the use of bi-directional telecommunications systems for the delivery of health care at a distance, is considered from medical, technical, legal, sociological, and psychological perspectives. The current status of telemedicine along with trends and issues are analyzed. Potential future impacts of telemedicine are identified along with recommendations for future research activity and regulation in this field.

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TELEMEDICINE: THE ASSESSMENT OF AN EVOLVING HEALTH CARE TECHNOLOGY

1. INTRODUCTION

The stated goal of health care planners and providers is to deliver health care to as many persons as effectively as possible. The ability to attain this goal depends heavily upon the local availability of health manpower and facilities, both frequently deficient in overall supply and inequitably distributed. One way of attempting to rectify this situation might be for the government to require that physicians practice in government-assigned locations, an action requiring radical policy and attitude changes, and a significant reallocation of resources.

Rather than following this complex route, health care providers often seek more expedient methods. Under the existing circumstances these methods often involve the utilization of a developing technology or the innovative application of an existing technology, which promises to contribute to the improvement of health care by facilitating the redistribution of health care services. However, the desired results are not always realized as initially envisioned. There may be positive or negative immediate and extended range side-effects of a diversified nature. Consequently, it is beneficial to assess the effectiveness and impacts of a technology before and during the various stages of its development and implementation.

The assessment of a developing technology is characterized by certain inherent limitations. This problem is quite apparent in the assessment of health care technologies where many procedures, devices, and systems may be entirely new, presenting the potential for unique and unexpected effects. However, despite their newness to the health care environment, some of these technologies may have been applied previously in other fields. For example, the videophone has been laboratory-tested and field-tested by industry and social-psychologists. The observations of the technology's effect in other fields may be combined with the available information in the health field and the assessor's creativity to distinguish and predict the impacts of the technology on health care. This entails looking well beyond the use of telemedicine to aid in solving specific medical problems to the social, psychological, political, and economic effects, all of which contribute directly or indirectly to the overall quality of the care ultimately delivered.

Too often, the process of evaluating innovative medical technologies has been left exclusively to the practitioners. This has meant that frequently a less than systematic process of evaluation has occurred, based largely on the unidirectional focus of the practitioner's perspective. This statement is not intended to diminish the importance of the practitioner's role in the evaluation of a technology, for it is he who will ultimately accept or reject it. Rather, this appeal for a more global approach to assessment is intended to strive towards the effective monitoring of the interests of all of those affected by the technology. It is believed that the involvement of scientists and social scientists with a broad range of perspectives is vital to developing a base sufficiently broad for a quality overall evaluation. It is with this viewpoint in mind that this specific study of telemedicine has been undertaken.

1.1 DEFINITION OF TELEMEDICINE

The term "telemedicine" generally implies the whole range of applications of telecommunications to medicine, including direct patient care, program broadcasts for medical education, the transmission of medical records and patient information (e.g., computer record keeping systems) within and between health facilities, and hospital administrative communications. However, for the purposes of this study, the term "telemedicine" will refer primarily to the use of interactive telecommunications systems in the direct care of patients. Interactive telecommunications systems include those which have the capacity for the transmission of audio and/or video signals in two directions. Direct care via interactive television ("IATV") includes diagnostic transactions ("telediagnosis"), "teleconsultations," and therapeutic transactions ("teletherapy", e.g., speech therapy and "telepsychiatry.")

1.2 THE TECHNOLOGY

Telemedicine systems generally consist of various terminal devices connected by electronic circuitry. Each of the telemedicine systems uses a selection of audio and/or video terminal equipment suitable for the types of medical services to be delivered. The transmission of signals between terminals can be accomplished via a cable system, a microwave system, a laser system, a satellite system, or a combination of more than one, depending on a variety of topographical, economic, and other factors. The technology is discussed at greater length in Chapter 5.

1.3 THE TELEMEDICINE SCHEME

The general scheme for the delivery of health care via telemedicine is based on the connection of a central medical facility to one or more remote (or "satellite") locations. The central medical facility is the location of the physician, medical specialist, or medically-related specialist. The patient is at the satellite facility, and may be joined there by his own physician in the case of specialist consultations. Depending on the type of health care delivered and legal restrictions, a physician's assistant provides varying levels of supportative aid at the satellite location. The role of the physician's assistant may range from adjusting the equipment for improved transmission quality to providing assistance in physical examinations.

In the case of direct primary medical care delivery, the patient presents himself to the physician's assistant at the satellite clinic. Depending on the policy and legal restrictions on the particular clinic, the physician's assistant may perform a preliminary medical examination. Subsequently, the physician's assistant may perform a minor treatment or begin a "programmed treatment," i.e., predetermined for the particular condition, according to observed symptoms, or call the central medical facility for a consultation via the telemedicine system. The physician will then interview and examine the patient with the assistance of the physician's assistant, and form his impression of the medical condition, i.e., "telediagnosis." His disposition of the case may include sending the patient home with or without treatment, to be followed up by the physician's assistant, or having the patient transported to the central medical facility for further evaluation and treatment. (See Figure 1.)

In cases where a medical specialist is required, he is called at the central medical facility to either aid a physician in diagnosing a case, i.e., teleconsultation, to assist and supervise a physician's assistant or other non-physician medical worker, or to provide direct therapy, e.g., telepsychiatry. In this case, the patient may be joined by his own physician at the remote location, or may be alone with the physician's assistant, as described above.

In the case of medically-related specialists, such as speech therapy, the specialist is at the central medical facility and the patient is at the satellite location, assisted by a physician's assistant, or possibly just a technician to control the equipment.

1.4 THE PROLIFERATION OF TELEMEDICINE

Prior to 1972, there were only about six telemedicine systems operating in the United States. (See Chapter 5.) Between 1972 and July 1974 approximately eighteen projects have been planned or initiated (see Table 1), characterized by a trend towards increased size and comprehensiveness of services. (See Table 2.) Concurrent with the acceleration of the rate of project development has been a growing number of predictions concerning the future use of telemedicine. For example, the administrator of the Blue Hill, Maine project "believes that the new (telemedicine) system may well be the pattern for delivery of rural medical care in the future." (1)*

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*The numbers in parenthesis in the text indicate references in the Bibliography.

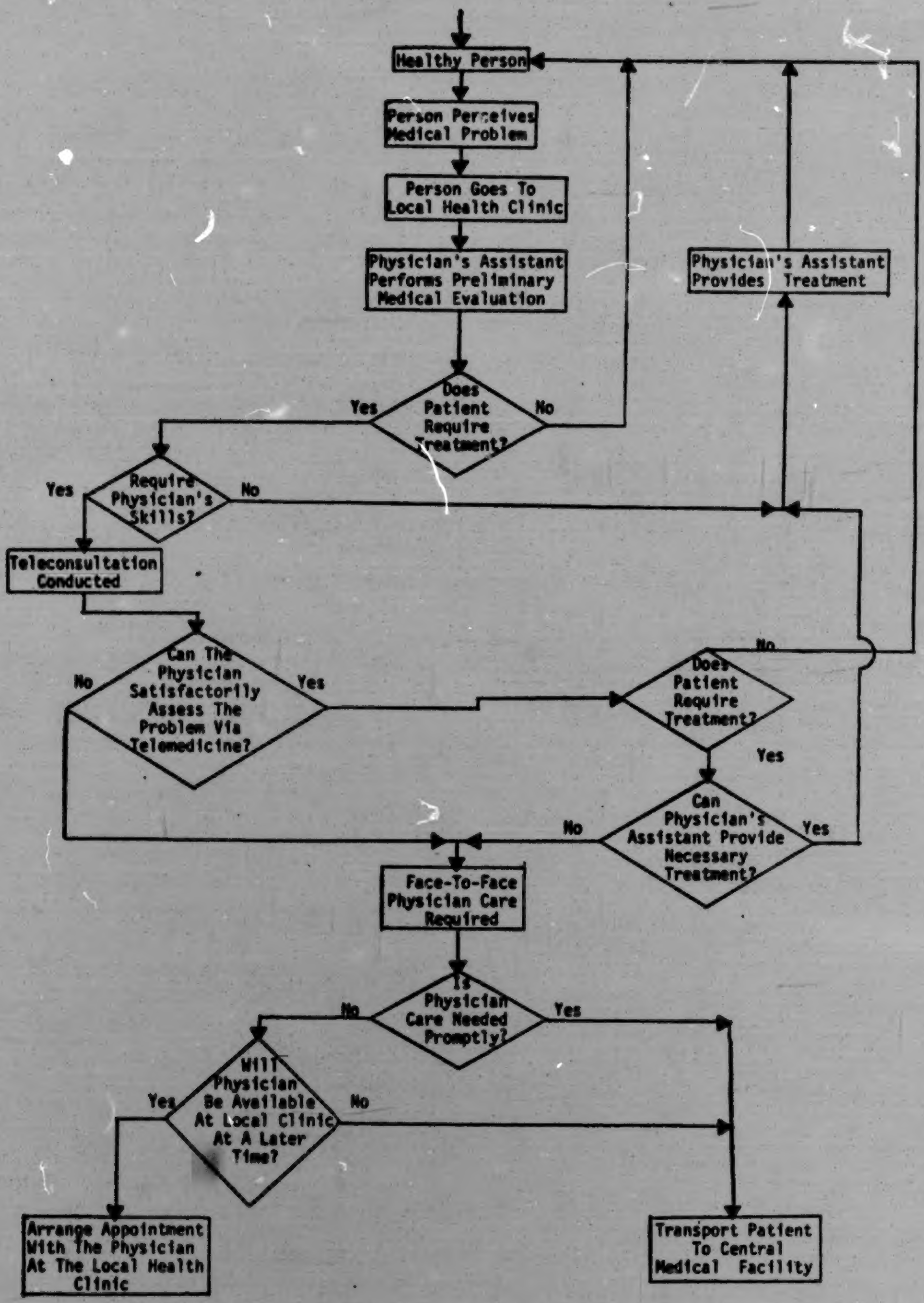
Healthy Person
Person Perceives Medical Problem
Person Goes To Local Health Clinic
Physician's Assistant Performs Preliminary Medical Evaluation
Does Patient Require Treatment?
Yes
No
Require Physician's Skills?
Yes
No
Physician's Assistant Provides Treatment
Teleconsultation Conducted
Can The Physician Satisfactorily Assess The Problem Via Telemedicine?
No
Yes
Does Patient Require Treatment?
No
Yes
Can Physician's Assistant Provide Necessary Treatment?
No
Yes
Face-To-Face Physician Care Required
Is Physician Care Needed Promptly?
No
Yes
Will Physician Be Available At Local Clinic At A Later Time?
Yes
No
Arrange Appointment With The Physician At The Local Health Clinic
Transport Patient To Central Medical Facility

Figure 1. The Telemedicine Scheme for Primary Health Care

Table 1. Telemedicine Projects (a)

	Project	Thesis Abbrevation	Location
1.	Massachusetts General Hospital-Logan Airport	MGH/Logan	Boston, Mass.
2.	Massachusetts General Hospital-Bedford V.A. Hospital	MGH/Bedford	Boston, Mass.
3.	Lakeview Clinic Bi-directional Cable Television System to Support a Rural Group Practice	Lakeview	Waconia, Minn.
4.	East Harlem Broadband Health Communications Network	Harlem-Mt. Sinai	New York, N.Y.
5.	Bethany/Garfield Community Health Care Network	Bethany/Garfield	Chicago, Ill.
6.	Case Western Reserve Univ. Anesthesiology Project	Case Western Univ.	Cleveland, Ohio
7.	Illinois Dept. of Mental Health Medical Center Complex/Community Mental Health Program	Illinois Mental Health	Chicago, Ill.
8.	The Cambridge Hospital Consultation System Between Physician Extenders at Neighborhood Health Clinics and Physicians at a Community Hospital	Cambridge Hosp.	Cambridge, Mass.
9.	Interactive Television - Blue Hill/Stonington, Me.	Blue Hill, Me.	Blue Hill, Me.
10.	Space Technology Applied to Rural Papago Advanced Health Care (b)	STARPAHC	Phoenix, Ariz.
11.	Alaskan Health Care Delivery Experiment (b)	Alaska-ATS-F	(Several locations) (c)
12.	Veterans Administration Experiment (b)	Veterans Administ.	(Several Locations) (c)

Table 1. Telemedicine Projects (continued)

	Project	Thesis Abbreviation	Location
13.	New Hampshire/Vermont Medical Interactive Television Network	New Hampshire/Vt.	Hanover, N.H.
14.	Remote Radiographic Communication Project	Nebraska Radiology	Omaha, Neb.
15.	Telemedicine Health Care Delivery in Dade County Florida Penal Institutions	Florida Penal Institute	Dade County, Fla.
16.	CTS Telemedicine Experiment (b)	CTS	(Several locations) (c)
17.	Nebraska Veterans Administration Project	Nebraska VA	Omaha, Neb.
18.	Rural Health Associates-Interactive Medical Microwave Television	Farmington, Me.	Farmington, Me.
19.	Ohio Valley Medical Microwave Television System	Ohio Valley	Columbus, Ohio
20.	Puerto Rico Telemedicine Project (b)	Puerto Rico	Ponce, P. R.
21.	Jacksonville Telemedicine Network	Jacksonville	Jacksonville, Fla.
22.	Cook County Hospital Department of Urology Picturephone Network	Cook County Hospital	Chicago, Ill.
23.	The Arizona Telemedicine Network (b)	Arizona Network	Tucson, Arizona
24.	Boston City Hospital Nursing Home Telemedicine Project	Boston City Hosp.	Boston, Mass.

(a) Compiled from telemedicine project reports known to the author as of July 1974.

(b) In planning stages.

(c) Satellite with multiple ground stations.

Table 2. Telemedicine Projects: Combinations of Interactants. (a)

	Satellite Clinic - Hospital	Prison/Nursing Home - Hospital	Hospital - Hospital	Intra - Hospital	Hospital - Other Institutions	Physician - Physician's Assistant	Physician - Physician	Physician - Specialist	Physician - Patient	Patient - Medically Related Specialist	Other (b)	Reference
MGH-Logan	x					x			x			(2, 3)
MGH-Bedford			x				x	x	x	x	x	(2, 3)
Lakeview	x					x	x	x	x			(4)
Harlem-Mt. Sinai	x					x	x	x	x	x		(5)
Bethany/Garfield	x		x	x			x	x			x	(6, 7)
Case Western Res.			x			x(g)						(8)
Illinois Mental H.	x		x	x			x		x	x	x	(9)
Cambridge Hospital (c)	x					x			x			(10)
Blue Hill, Me.	x					x			x			(1)
STARPAHC (d)	x					x			x			(11, 12)
Alaska-ATS-F (d)	x					x	x		x			(13)
Veterans Admin. (d)	x		x									(13)
New Hampshire/Vt.			x		x		x		x	x	x	(14)
Nebraska Radiology (e)	x						x					(15)
Florida Penal Inst.		x			x				x			(16, 17)
CTS (d)	x		x									(18, 19)
Nebraska VA			x				x		x		x	(20)
Farmington, Me.	x				x				x			(21)
Ohio Valley			x				x	x	x			(22)
Puerto Rico (d)			x				x	x	x			(23)
Jacksonville (f)												
Cook County Hosp.				x	x		x	x	x			(24)
Arizona Network (d)	x				x			x	x			(25)
Boston City Hosp.		x			x							(26)

(a) The data presented in these tables has been collected from reports issued by the telemedicine projects. Every effort has been made to maintain accuracy in the collection and presentation of this large amount of information.

(b) Includes communication involving non-physician and non-physician's assistant health care worker.

(c) Operation terminated.

(d) Not yet operational.

(e) X-ray transmissions only.

(f) Information not available.

(g) Nurse anesthetist.

The director of the Massachusetts General Hospital Telecenter, Dr. Kenneth T. Bird, believes that "the initial 2-hospital system is now ready for regional development and regional use pending its duplication elsewhere in the United States. The hope is to mold it into a nationwide interactive health telecommunications system with its subsequent dramatic effect for veterans and others." (3) Plans for the development of a telemedicine network have already been formulated for the Veteran's Administration Regional District No. 1, which includes much of New England. (27)

A major factor in the recent proliferation of telemedicine projects has been the activity of the Health Care Technology Division of the Department of Health, Education, and Welfare, under the direction of Dr. Maxine Rockoff. The goal of the "Logistics Program" is to "develop and analyze communication and transportation networks for alternative models of health care systems which provide comprehensive health care at reasonable costs." The objectives of the Logistics Program are "the exploration of technological, medical, and social feasibility of using communication and transportation technologies in overcoming the distance problems of health care systems, and the development of methodologies and 'handbook' kinds of information to be used by systems engineers, in consultation with health care providers, to design cost-effective communication and transportation networks for health care system." The Logistics Program is divided into three phases. Phase I was initiated in 1972 with the funding of 7 of the projects listed in Table 1 (See Appendix 12.1 for a summary of the Logistics Program projects) to explore the feasibility of two-way interactive visual communications technology in the delivery of health care.

Phase II will include the collection of data including the amount and frequency of utilization for specific purposes, cost-benefit analysis, and exploration of the effects of technological improvements. Phase III will be the analysis and creation of cost-effective communication and transportation networks for a number of different health care delivery system models. (28)

In addition to the Health Care Technology Division of HEW, The Veterans Administration, NASA, The Lister Hill Center for Biomedical Communications and several private foundations provide support and planning for the development of telemedicine systems. Their role is discussed in later sections.

The rapid development of telemedicine systems over the past two years has produced significant field observations. Concurrently, social-psychological laboratory research has begun to yield significant new information on the nature of electronically mediated human communication. The interaction of both areas is only beginning to become clear, in addition to the new social, legal, and moral issues related to it. In terms of the stage of development and deployment of the technology, the present appears to be an opportune time to assess telemedicine.

1.4.1 Related Telemedicine Studies

In the 1960's when telemedicine projects were few in number, project reports appeared periodically. Despite the activity in the field of telemedicine in recent years, the published literature is rather limited. In 1970, Michael Crichton described telemedicine in his popular book, Five Patients. (29) In 1971, Konrad Kalba produced a report for the Sloan Commission, Communicable Medicine: Cable Television and Health

Services (30), which dealt with the application of telecommunications to health care delivery in a broad sense. The following year Ederyn Williams of The Communications Studies Group of University College London released a "working paper" entitled Communications and Medicine: Impact and Effectiveness (31) which explores the numerous uses of telecommunications in medicine and projects into the future. The same year Tom Willemain of the Massachusetts Institute of Technology developed quantitative methods for the systematic planning and evaluation of telemedicine systems in his report, Planning Telemedicine Systems (32).

As described above, 1972 represented an important point in the development of telemedicine, because many new projects were funded that year. In the interim period numerous project reports were produced, but to the knowledge of the author only one report with a broader scope was released, Telecommunications and Health Services by the ABT Associates. (33) At the time of this writing the situation is undergoing change. At least two full-length books on telemedicine are reported to be in press. Rashid Bashur, Patricia Armstrong, and Zakhour Youssef of the Department of Medical Care Organization of the University of Michigan School of Public Health have compiled a collection of papers by experts in medical care and telemedicine entitled Telemedicine: Explorations in the use of Telecommunications in Health Care, which should be available in Fall, 1974. (34) The second book, written by Ben Park of The Alternative Media Center of New York University, covers a broad range of topics similar to those included in this study and should be available during summer, 1974. (35)

1.5 OBJECTIVES

The purpose of this study is to describe telemedicine, assemble and analyze information on its current and future use, and to assess what its potential effects, both positive and negative, may be. Significant attention is given to the characterization of the state of American health care, based on the firm belief that a technology's effects cannot be fully understood without a clear perspective of the social environment in which it will be used. An attempt has been made to examine telemedicine from the point of view of the patient, physician, engineer, and social-psychologist, all of whom play important roles in the actual development, use, and evaluation of telemedicine. Specifically, the research undertaken was intended to achieve the following:

(i) Document and describe the social conditions prompting the development of telemedicine.

(ii) Consider the effects of innovative health care delivery schemes and new roles for health care personnel, and the process by which these are legitimized.

(iii) Collect and analyze information on the nature and extent of past, current, and planned telemedicine projects.

(iv) Survey the policies and operating practices of past, current, and planned telemedicine projects.

(v) Determine the limitations inherent in the technology and how these may affect its applications.

(vi) Predict the effects of telemedicine on all aspects of the present health care delivery system.

(vii) Explore the legal and ethical issues arising from the use of telemedicine.

(viii) Designate the various interest-groups and their criteria for acceptance or rejection of telemedicine.

(ix) Identify additional data, and methods for obtaining it, necessary for making a more complete assessment of telemedicine.

1.6 METHODOLOGY

This interdisciplinary study* of telemedicine is approached via the collection, evaluation, and synthsis of research findings and observations in the areas of medicine, engineering, sociology, and psychology. Published reports, personal correspondence, and direct observation are the sources for the information presented. Correspondence with the staffs of most of the projects has occurred on one or more occassions throughout 1973 and 1974. On-site tours of the Massachusetts General Hospital Telecenter and the Mt. Sinai School of Medicine projects were made in July, 1974. At the same time informal discussions with members of the Massachusetts General Hospital, Mt. Sinai School of Medicine, Cambridge Hospital, and Boston City Hospital telemedicine projects were held. An extensive search of the literature has been made to aid in establishing the proper perspective of telemedicine within the contemporary health care delivery system.

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*The range of this study places it somewhere in the vicinity of the new and growing field of technology assessment. However, whereas full-blown assessments often are undertaken by interdisciplinary teams with fairly sizeable budgets, this study was performed by the author over a period of one calendar year while enrolled as a full-time graduate student at Washington University.

In this effort to link information from many diverse sources, certain areas are treated more superficially than others, the intention being to present them as background material relevant to the topics of major interest. The findings and conclusions of many other researchers are drawn upon throughout this study. Some are challenged and others are reinterpreted where deemed appropriate, hopefully resulting in an original approach to certain topics.

Chapter 2 is intended to establish the necessary perspective for understanding the development of telemedicine. The next chapter examines the issues related to the use of the physician's assistant in telemedicine, one of the most important factors in the quality and ultimate acceptance of telemedicine. Chapter 4 provides a brief overview of the application of telecommunications to health care delivery. Chapters 5 and 6 deal with the telemedicine systems in operation, and the evaluations performed to measure their clinical effectiveness.

To emphasize the importance of factors beyond the technical feasibility, Chapter 7 is devoted to the examination of some social-psychological factors related to telemedicine. Chapter 8 summarizes some of the legal issues resulting from the delivery of health care via telemedicine. This is followed, in Chapter 9, by the presentation of information which suggests the possible direct effects of telemedicine on physician migration and settlement. Chapter 10 draws upon the information presented in the first nine chapters, to delineate the factors which may work for or against the acceptance of telemedicine on a large scale. The final chapter presents the conclusions drawn from the information presented and recommends directions for future research and possible regulation. A rather extensive bibliography is presented following Chapter 11.

It is hoped that the approach and findings of this study will be responded to, negatively or positively, by persons in positions with power to effect change. Any meaningful feedback will have made this more than just an academic exercise.

2. HEALTH CONDITIONS PROMPTING INNOVATIVE APPROACHES

> "Health is a basic human right. Comprehensive, continuous, and personal care should be available to all." (36)

The transformation of the above "should" into an "is" is probably the greatest challenge facing health and social service planners and providers in the U. S. in the 1970's. The evolution of the concept of health care as a right of every individual has brought with it an unprecedented demand for health care services. In attempting to supply these services, health care planners and providers have become keenly aware of certain factors that must characterize the plan they offer if it is to be successful for the population of patients concerned. The necessity for the design of different programs for different populations is attributable to culture-bound factors of medical care and to the complex interaction of health care and other social services (e.g., housing, education, sanitation).

In evaluating a new scheme for health care delivery within an established system, i.e., telemedicine, it is important to consider the optimal goals of the health care provider, to establish a clear basis for comparing the new program to the "ideal" program. In performing this comparison, the points of potential success or failure may become more clear.

2.1 GOALS OF A HEALTH CARE DELIVERY PROGRAM

A health care delivery program can exist as an independent entity only within certain limits. These limits are dictated largely by the quality of the other social services available. For example, poor quality and overcrowded housing places certain restrictions on the upper limit of the population's health that can be achieved even with infinite health care services. With these limitations understood, goals for a health care delivery program can be formulated. Several health care planners and providers have included the following factors as necessary for an acceptable health care system: (37, 38, 39, 40)

(i) Availability: the existence of needed services, equipment, supplies, and facilities.

(ii) Accessibility and Affordability: the provision of care that is offered at locations, times, and costs commensurate with the life styles and resources of the consumers.

(iii) Acceptability: the services are offered in a manner which makes the patient feel welcome, and the providers feel competent and appreciated.

(iv) Appropriateness and Continuity: the health care available covers the realm of ailments and patient complaints, from the simplest to the most complex, either directly or through a series of accessible health care providers.

(v) Competency: delivery of services judged to be of a high technical medical quality by professional peers, and judged to be of a high humanistic quality by the patients.

(vi) Responsiveness to Change: the health care providers take advantage of progress in health care resulting from technological advances and medical discoveries, in addition to reacting to new consumer requirements.

In evaluating a new scheme for health care delivery, careful attention must be paid to these factors; for the failure to do so may result in poor quality services, or effectively unavailable services, i.e., those that the consumers will not use. The offering of "any" health care services, without careful attention to the social, political, and economic characteristics of the community may not solve the health care problems of the population. (41) In short, "there is no simple blueprint for study and solution of health problems that is applicable to all communities in all situations. The cultural base of any community is important in determining how human and natural resources are treated." (41, p. 208)

2.2 INDICES OF HEALTH QUALITY

The accurate measurement of health quality is rather difficult because there are no precise indices of "good health." Traditionally, health quality has been measured by comparing statistics which summarize the absence or low level of services in an area in a rather gross way. These indices include infant mortality rate, life expectancy, incidence of specific diseases, and premature births. In addition, measurements of patient waiting times, unavailability of certain services, and ratios of health care personnel to populations have been used to indicate more specific deficiencies in the health care delivery system.

Although these indices are less than optimal measures of health quality, they do indicate gross gaps in the availability of services. Until greater agreement is reached on the definition of optimal levels for various services, we are left with making macroscopic comparisons based on these indices.

The infant mortality rate is the number of deaths of infants under one year of age per 1,000 live births. (42) This is generally considered a sensitive indicator of the effectiveness of (or lack of) the medical care delivered, and of the guidance provided to the public by the medical profession (e.g., education regarding prenatal and postnatal nutrition of the mother and child.) Life expectancy is the average age that a person lives to within a population. It is generally considered to be an overall measurement of the effects of fatal illness throughout an individual's entire life-time. The incidence of a specific disease and premature births generally reflect the level of accessible medical care, in addition to the quality of other social services (e.g., housing and sanitation.) The measurements of the absence of services, long delays in receiving care, and low ratios of health care personnel to population are probably the most direct indices of care quality.

Finally, several problems arise in the interpretation of the health statistics presented. Traditionally, the tendency has been to aggregate populations by jurisdicitonal or geographic boundaries. This has frequently resulted in the "lumping together" of populations which differ drastically in regard to socio-economic characteristics, resulting in "average" statistics which distort each population's conditions. The phenomenon is well-demonstrated by almost any urban area in the United States which contains an economically depressed area a very short distance from an affluent area. The overall infant mortality rate, life expectancy, and physician-to-population ratio for the entire area may appear to be good, but, in reality, may be excellent for the affluent population and extremely poor for the economically depressed population. (43, 44) And, even when attempts are made to measure the availability of services at a finer level, the statistics may still be misleading. For example, the location of a physician's office in a ghetto area does not always mean that the physician serves the ghetto population around him. (44)

2.3 THE RURAL HEALTH CARE PROBLEM

At least one out of four persons in rural America is poor, using even the most conservative definition for poverty. (45) Overall, 27%

of the U. S. population lives in rural areas (41), while 40% of the poverty is concentrated there. (45) The absence of wealth due to the generally poor economic conditions in rural areas makes the financing of health care services difficult. However, even in rural areas which could provide monetary resources for health care services, the economic difficulty in supplying services is compounded by numerous other problems. Significant among these is a dispersed, dwindling, and changing population. (41, 45, 46) For example, a recent study of 8 West Virginian (Appalachia) counties revealed a population decrease of 29% during the last 20 years. (47) A closer examination of these figures shows that the change in population was marked by an increase of those over 55 years of age, while the younger population decreased. Apparently, many of the older persons returned home to Appalachia when they became old and sick and had been laid off from their jobs in other areas. Their return added to the economic depression, and the demand for health care services in the area.

Rural areas have such dispersed populations that it is difficult to organize social services, such as health care, around central points. For example, much of the native population of Alaska is scattered in about 175 villages, with populations ranging between 25 and 500, over a large geographic area, separated by mountains and other geographic barriers. (48) A similar problem exists for the Papago Indians in southern Arizona. Their population of 8,000-10,000 permanent residents is dispersed in 75 villages over a 10,000 square mile desert area. (25) In addition, some small communities are geographically isolated, often by natural boundaries or inaccessible roads. For example, Stonington, Maine, with a population of 1,300, lies only 30 miles from the nearest community with a hospital, but it takes about an hour under optimal conditions to travel the roads separating Stonington and the hospital. (1)

In addition to the problems associated with the changing and diminishing population are the generally weak private and government institutions in many rural areas, which are relatively helpless in securing aid for rural communities. This has often precluded the development of a decent system of transportation, which has caused a continuous diminishment of geographic accessibility to these rural areas. (41, 49) For example, the West Virginia State Road Commission reported that in 1965 only 20% of the road mileage within the 8-County area (discussed above) met minimum specifications. (47)

The changing population, poor economic conditions, geographic inaccessibility, and deficient municipal services provide the foundation for the direct and obvious problems of rural health: there are simply too few or no medical services available in certain areas. These services depend on health care personnel to deliver them, and they are just not available. There are as few as 42 non-federal practicing physicians per 100,000 persons in some rural areas, compared to as many as 195 per 100,000 persons in some metropolitan areas, and this is steadily growing worse. (50) (See Figure 2.) The absence of specialists and even licensed physicians is an especially difficult issue for many rural areas. (47) In 1959 there were 64.4 medical specialists per 100,000 persons in metropolitan areas compared to 26 per 100,000 in rural areas. There is no indication that this ratio is improving. In 1971, there were 133 counties in the United States

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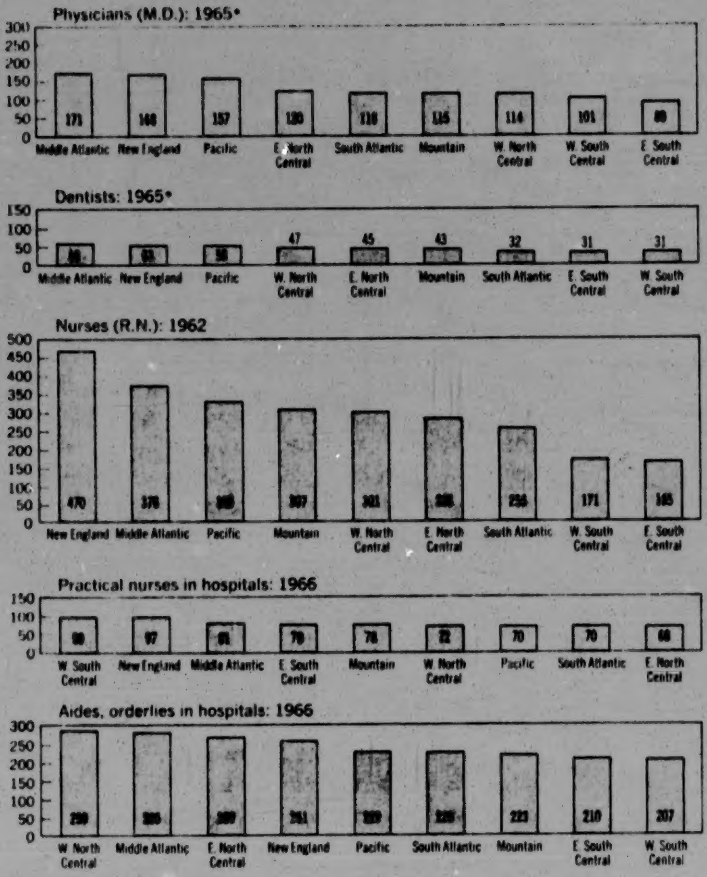

*NonFederal per 100,000 civilian population.

Figure 2. Active Health Personnel Per 100,000 Population in the U.S. By Region. From Reference (51).

without a single practicing physician, with a total aggregated population of 482,600 persons. (50)

In the study of the 8-county area in West Virginia it was found that the shortage of health care personnel was constantly decreasing. At the time of the study (1972), there were only 23 physicians and 7 dentists in active practice in the area, with two of the counties having not one physician or dentist. Earlier records indicate that in 1938 there were at least 5 physicians in each county and as many as 15 in three of the counties. The two counties found to be doctorless in 1972 had had 5 and 10 physicians, respectively. Physician-to-population ratios in the 8-county area have continually decreased over this time period from 80 physicians per 100,000 persons in 1938 to 65 per 100,000 persons in 1950, to 53 per 100,000 persons in 1960, to 28 per 100,000 persons today. The physicians remaining in rural practice are significantly older than their urban counterparts. (47) (See Table 3.)

To emphasize the conditions in rural America, Joseph T. English of the Health Services and Mental Health Administration, Department of HEW, made the following observations about Lowndes County, Alabama:

> "...the population, a rural ghetto, is strewn over 716 square miles; there is not a single hospital; roads are so poor that you need a four-wheel drive jeep to traverse the terrain after a heavy downpour; medical resources consist of three physicians, one of whom has not been practicing medicine for many years and another who is in his late 70's." (53)

In addition to the critical shortage of physicians and medical specialists, there is also a substantial need for medically-related personnel. (See Table 4.) For example, the 8-county area of West Virginia discussed above has less than one-third the number of dentists

Table 3. Age Distribution of Non-Federal Physicians by County Group, 1959*

COUNTY GROUP	PHYSICIANS, PERCENTAGE DISTRIBUTION				
	22-34 years	35-44 years	45-54 years	55-64 years	65 & over
United States	21	28	23	14	14
Metropolitan-adjacent	22	27	23	14	14
Greater metropolitan	23	26	23	15	13
Lesser metropolitan	23	29	22	13	13
Adjacent to metropolitan	15	29	23	14	19
Isolated	16	29	22	13	20
Isolated semirural	16	30	22	13	19
Isolated rural	18	24	18	12	28

*From reference (52).

Table 4. Health Professionals Practicing in Eight Isolated Counties of West Virginia*

	Number	Population Ratios	Eight County Area per 100,000	West Virginia per 100,000
Physicians and Osteopaths	23	1/ 3,522	28.4	91.7 (1968-69)
Dentists	7	1/11,573	8.6	36.1 (1967)
Nurses RN	82	1/ 988	101.2	276.6 (1966)
Pharmacists	20	1/ 4,051	24.7	29.1 (1968)
LPN's	73	1/ 1,110		
Physical therapists	0	-		
Medical technicians	6	1/13,502		
Emergency Services--Transportation				
Local hospital	0			
Rescue squad	0			
Ambulance service	1			
Fire or police department	1			
Funeral homes	19			
Other	0			
Public Health Personnel, September 1969				
Nurses	9	1/ 9,001	11.1	
Sanitarians	3	1/27,004	3.7	
Clerks	9	1/ 9,001		
Home health aides	1	1/81,014		

*From reference (47).

that it had in 1958. There are no physical therapists in the region, only 6 medical technicians, and almost a complete lack of skilled nursing care, home health services, rehabilitative care, and extended home care. Family planning services are generally lacking, as are public health programs (e.g., sanitation, health education, and home visits.)

The region is as deficient in medical facilities as it is in personnel. Only 4 of the 8 counties in the study have hospitals. There are vehicles designed specifically for emergency medical care in only 2 of the counties. The others must rely on funeral vans for emergency services. (47)

The limited health care services are clearly reflected in the health indices. In 1967, the average number of visits to physicians per person ranged from 4.7 per year in metropolitan areas to 3.3 per year in rural areas. (54) This disparity is more clearly demonstrated in the comparison of patient use of selected medical specialists and practitioners. In 1966, pediatricians saw about 25% of the children living in metropolitan areas, about 12% of those living in rural nonfarm areas, and 4% of those living on farms. Obstetricians saw about 10% of the women living in metropolitan areas, less than 6% of those living in rural nonfarm areas, and less than 3% of those living on farms. It is interesting to note that hospital use by rural persons and city people is about the same (54), suggesting that people will get to the hospital somehow, if it is necessary.

Special attention must be given to the health status of the American Indian, because it is the least satisfactory of any group in the United States. Illnesses such as tuberculosis, gastroenteritis, and pneumonia have mortality rates 2-8 times greater for Indians than among non-Indian populations, and infant mortality is two times the national average. (25)

In short, the residents of a large and growing portion of rural America face increasing difficulty in securing medical care. The maldistribution of physicians, medical specialists, and medically-related specialists, compounded by poor transportation systems, poverty, and changing population, makes it difficult or impossible for the patient to see a physician when he needs to. This barrier to care results in a pattern of delaying medical treatment until a crisis situation exists, exerting an even greater strain on the few existing facilities. (55, 56)

2.4 THE URBAN HEALTH CARE PROBLEM

Physicians, along with the general U. S. population, have followed a trend towards urbanization in recent years. (57) Studies reveal that the number of physicians per capita population rises steadily as population concentration increases in metropolitan areas. (58, 59) However, the phenomenon of averaging the number of physicians per population in a region (i.e., a city or metropolitan area), discussed above, creates a distorted impression of available physicians' services in urban areas. The physicians practicing within the metropolitan regions are usually concentrated in certain areas and serve only a select population. Although the geographic distances may be small in a city compared to a rural area, other barriers exist, including a lack of effective transportation and socio-economic and racial differences. (55)

The maldistribution of physicians within cities has reflected the trend in population change from a white toward a non-white majority. Many physicians have fled to the suburbs leaving vacancies in the inner city, and others have grown old, not to be replaced. (55) A study done in 1969, by the Harvard Medical School Commission on Relations with the Black Community, portrays the average physician practicing in Roxbury (Boston's predominately Black ghetto) as being 66 years old and, in one out of two cases, a graduate of a medical school which no longer exists. (60)

A survey of several inner city areas reveals a physician-to-population ratio which differs significantly from the national average of 127 physicians per 100,000 population. (See Table 5.) The disparity between the number of specialists in ghetto and affluent areas is even more dramatic. For example, Chicago has 18 specialists per 100,000 persons in its poverty areas and 53 per 100,000 persons in its non-poverty areas. (61)

The large population-to-physician ratios in urban poverty areas are most distressing when examined over a period of many years, because they reveal a trend towards a continuous increase. For example, the Southside Chicago community of Kenwood-Oakland had 110 physicians serving a population of 28,400 white persons in 1930. In 1968, 5 physicians served a Black population of 45,400. (42) In 1940, 950 physicians provided care for Baltimore's 850,000 residents. They were relatively evenly distributed throughout the city, and most were providing primary care. As numerous physicians migrated to the suburbs and others tended towards specialization, this ratio has been drastically altered. In 1969, there were 300 physicians providing

Table 5. Approximate[a] Physician-to-Population Ratios in Some Major U. S. Inner City Ghetto Areas[b]

CITY	NUMBER OF PHYSICIANS[c]	POPULATION	YEAR	REFERENCE
Boston	40	80,000	1969	(60)
Cleveland	45	100,000	1968	(62)
Los Angeles	41	100,000	1965	(62)
Baltimore	100	300,000	1969	(44)
Chicago	62	100,000	1965	(44)

(a)"Inner city ghetto areas" are not always precisely defined.

(b)This data was presented in the individual reports of several participants at a conference on Medicine in the Ghetto held at Portsmouth, New Hampshire in June 1969. (55)

(c)The average physician-to-population ratio in the United States is 127 physicians per 100,000 population.

care to 920,000 people in the entire city, and only 100 physicians providing care to the 300,000 persons in the inner city. (44)

The gross shortage of primary health care in the inner city areas is clearly manifest in the health indices. In 1969, the infant mortality rate for the entire United States was 25 per 1,000 live births. In the city of Chicago it was about 30, overall. In poverty areas of Chicago the rate was 38.5 compared with 22.2 in non-poverty areas, while the rate for nonwhites was 43.0 compared with 22.2 for whites. (42) Perhaps more clear indicators of the poor health level are the morbidity rates for certain diseases. According to a 1967 study of health statistics in Chicago's ghetto areas there was a 200% higher incidence of premature births, 200% more cases of tuberculosis, 550% more new cases of venereal disease, and 100% higher death rate from cervical cancer than in Chicago's non-poverty areas. (63) As discussed above, these indices are attributable to the poor level of health care services as well as the lack of other social services.

In short, the average U. S. inner city resident is likely to have difficulty in obtaining health care due to a gross shortage of accessible care. Because of factors such as poor or non-existent transportation, inability to afford care, health care provider hostility, etc., he is unlikely to leave the ghetto to obtain health care. Instead, he is likely to wait for a crisis situation to develop, at which time he will seek aid at a hospital emergency room or clinic. (55, 56)

2.5 THE OVERALL HEALTH CARE PROBLEM

> "The heart of the traditional medical-care delivery system is the physician. Whether he practices alone or in a group, he is still directly involved in the care of the patient at

> every important stage; from the initial interview to the final discharge. Any realistic solution to the medical-care problem must therefore begin by facing up to the facts about the supply of physicians." (64)

The lower level of health care quality in ghetto and rural areas may be directly attributed to the unavailability of primary care, due to the limited amount of available physician time to deliver these services in these areas. Frequently the underlying causes for these shortages are treated separately for urban and rural areas. In actuality, these areas suffer from many common problems, due primarily to the patient's separation from health care services by barriers; in the rural environment they may be geographic; in the urban environment they may be socio-economic or racial. The overall shortage of health care services may be reduced to three basic factors:

(i) A generally limited supply of physicians in primary care practice, due to medical specialization and an insufficient number of medical school graduates.

(ii) Poor geographic distribution of physicians, medical specialists, and medically-related specialists.

(iii) Suboptimal utilization of available professional time.

The shortage of health care personnel is most obvious in rural areas, where there may be no health care services for many miles around. The maldistribution is most apparent in inner city ghetto areas, where the large medical centers attract most of the physicians and the ghetto areas in close proximity have a few overworked physicians.

The general shortage of physicians for primary care is a very difficult issue to approach. The numerous studies that have been conducted (e.g., 50, 51, 52, 65, 66) have adopted many different criteria in their assessments of the problem. Differences are most notable in the selection of the data bases for both physicians and population; some have chosen to include the entire U. S. population, including overseas possessions, while others have been limited to the U. S. mainland; some include federal and retired physicians in calculating supply, while others exclude these; and, there is little consensus on the optimal number of physicians needed for primary care, although some have defined it according to their own terms. (65)

Rather than discussing this issue at length, for the purposes of this study it is more realistic to acknowledge that there are clear geographic maldistributions of health care providers in the U. S., resulting in certain areas with grossly deficient health care services as discussed above. The deficiency in these health care services at the primary level results in the absence of an entry point for the patient into the health care system, thus, denying comprehensive care in addition to the lacking primary care. The lack of an effective entry point is due not only to the lack of physicians in certain areas, but also to other factors such as long waiting times and an unclear "cognitive map" of health care services, resulting in patients who do not know who to see for care for particular problems. Furthermore, even if a patient does figure out who to see, the lack of a primary care provider to coordinate care may result in fragmented care which might not really solve his problem.

Another significant factor decreasing the potentially available physician time is the physician's suboptimal utilization of his professional time. Many experts believe that certain tasks, traditionally performed by physicians, could be effectively administered by less broadly trained personnel. (51, 67, 68, 69, 70)

Dr. J. William Gavett, of the University of Rochester's Graduate School of Management, has described a method of medical case classification as an aid to coordinated planning of ambulatory care. His model classifies medical cases according to case complexity. Cases are categorized as A (urgent, complex, and resource-intensive), B (intermediate), and C (simple). A sample analysis of several hundred physician visits revealed 82% of cases in the "C" category, 8% "B", about .4% "A", and 9% "other". The distribution of skill levels required to treat these cases was investigated and it was judged that about 61% of the cases could be handled by a general practitioner, about 9% by a specialist, and about 30% by paramedical personnel. (71)

In recent years, as technology has become commonplace in patient care, many new individuals have joined in the direct care of patients, often substituting for the physician in certain tasks. However, a great deal of work remains to be done to determine the extent to which tasks normally performed by a physician can be performed by others and the disirability of the transfer of tasks from physicians to others.

In short, physicians, and the health care services that depend on them, are unequally distributed. Whether a "real" overall shortage exists is still open to debate; but, in the meantime there are large populations with little or no health care. Plans need to be devised to produce more physician time, overall, and, a more equitable distribution throughout the United States.

2.6 FACTORS IN PHYSICIAN MIGRATION AND SETTLEMENT

In developing an understanding of the factors influencing physicians' choices of locations for practicing medicine, it is important to consider their attitudes and family backgrounds which contribute to these attitudes. In a study of two public and two private medical schools in 1965, it was found that 34% of the students came from families in the top 3%, socioeconomically, and that only 8% came from families in the bottom 40%, socioeconomically. (Rosinski, cited in (72)) In a study of student graduated from six public and six private medical schools, it was found that 60% of the students had fathers who were themselves physicians or other professionals, executives, or small businessmen. This compares to only 15% of the total U. S. population employed in such occupational groups. Only 18% of the graduates in this study had fathers who were laborers, an occupational group which comprises 58% of those employed in the U. S. (Lyden, Geiger, & Peterson, cited in (72))

Given a supply of physicians who disproportionately represent the more affluent portion of our society, one might expect physicians' attitudes towards health care to reflect a middle-upper class orientation. A random sampling of U. S. physicians (with a 76% return) revealed an attitude characterized by little sympathy for the poor. For example, less than 20% of the physicians agreed with the statement, "Every doctor should serve for two years before settling down," and over 40% agreed with the statement, "A dissolute way of life is the cause of many diseases among the poor." (Fredericks, Kosa, & Robertson, cited in (72)) This attitude is also apparent in some younger doctors, as a survey of 28 pediatric residents revealed. Only 2 of the 28 surveyed "wanted to work in community clinics in poverty-stricken urban areas." These two saw themselves as directing the clinic from an academic base. The study also revealed that none of the 28 surveyed "planned a career that would include personal treatment of the poor patient as the essential part of his medical practice." (Roth, Kosa, & Alpert, cited in (72)) The extent to which these attitudes may have changed since the surveys were conducted is unknown to the author.

The physicians' negative attitudes towards the poor are manifest by their avoidance of areas with large poverty populations. As the above studies show, it goes more deeply than just economics. This has been somewhat confirmed by the inability to bring more physicians into the ghetto of New York City, as of 1969, even though physicians' fees were guaranteed by Medicaid (73), and into the Appalachian counties discussed above as of 1973, even when a guaranteed salary was offered. (47) Factors such as high crime rates in inner-city areas have clearly contributed to the present situation.

The situation in rural America is similar to that in the inner cities, but involves several distinct factors. The profile of a typical rural physician shortage area may be characterized as having a low level of economic development, geographic isolation, a dwindling population, and little cultural and recreational opportunity. (45, 46) In short, the rural areas often cannot compete with the conveniences and cultural opportunities of a metropolitan area, so the doctors are "lured away by the cities." (49)

Several surveys have been conducted to determine the specific factors influencing physicians' choices to practice in rural areas or small towns. Among the most frequent responses are the following considerations: (47, 57, 74, 75, 76)

(i) Physician's background, i.e., physicians in small towns had predominantly small town backgrounds.

(ii) Access to continuing medical education and opportunities for professional contact and professional growth.

(iii) Availability of medical facilities, emergency services, and qualified personnel.

(iv) Hours of practice and general demand for services by local residents.

(v) Availability of social and cultural activities.

Unfortunately, the physicians that have chosen to practice in rural areas have found that the demands placed upon them by the residents are extraordinary. Physicians practicing alone can often find little relief from their work, and, instead, find resentment when they leave the area for even a single afternoon or evening. (47)

In short, the factors involved in the attraction and retention of a physician in certain rural and urban areas are complex. They represent an interaction of a broad range of social, economic, and political possibilities; and, there are no clear-cut solutions in sight.

2.7 ACTIVITIES TO RECRUIT MEDICAL PERSONNEL FOR SHORTAGE AREAS

The recruitment of health care personnel for shortage areas is as complicated as the factors creating the inequitable situation. First, there is the problem of the pool of available physicians. Surveys carried out in the late 1960's indicate that physicians are predominantly from the upper-middle class socioeconomic group, with negative or indifferent attitudes towards the health care problems of the poor. Secondly, many rural and urban areas are unattractive compared to the suburbs between them. Finally, the conflicts resulting from the differences in attitudes of doctors and patients often results in dissatisfaction. In response to these factors, several courses of action have been pursued, with various degrees of success.

Some rural communities have built medical facilities and guaranteed incomes for physicians who would practice in their area. For example, Clay County, West Virginia (one of the 8 counties discussed above) guaranteed a salary of $36,000 per year to any physician who would agree to serve the area. As of 1972, several physicians had inquired, but Clay County remained doctorless. (47) Other towns, such as Estancia, N.M., have secured funds, built medical facilities, and are still unable to recruit doctors. (77) Some urban areas face a similar dilemma; they have existing facilities which cannot be adequately staffed.

Efforts have been made by some communites to make themselves appear more attractive to physicians. Several states have held "job fairs" in which physicians are brought together with rural community leaders in an effort to help place medical manpower in places of need. (78)

A third approach to recruiting doctors for shortage areas has been the offering of monetary and other incentives to medical students. Some governmental agencies offer monetary support for medical students in exchange for an agreement to practice in shortage areas. Other incentives have included exclusion from the military draft in exchange for service in shortage areas, as was done with the Indian Health Service during the Vietnam war.

A fourth approach is the recruitment of medical students from shortage areas. Some studies (57) indicate that there is a tendency for doctors to practice in areas similar to those in which they were raised. However, there is the possibility that the environment of an affluent medical center may influence students' attitudes, such that they will not return to an area similar to where they were raised. The incorporation of more of the social aspects of medicine into the medical school curriculum, along with more clinical practice in rural and urban shortage areas may help to diminish this problem. (72, 79) As of 1972 at least 43 medical schools offered a preceptorship program, which allows the students to practice with a physician, usually in a rural community. Initial results indicate that students do return to the community to practice. (79)

Finally, frequently it has been suggested that a drastic increase in the number of medical school students would alleviate the problem of doctor-short areas. There is little doubt that an increase would make more medical care available in some areas; but, its effectiveness on a large scale is questionable, because there is little reason to believe that an increased number of doctors, with the same attitudes and backgrounds as the current pool of physicians, would result in an adequate supply of physicians in rural and inner city areas.

These efforts to recruit more physicians have had some effect; that is, they have helped to place some physicians in some shortage areas. However, the number of doctorless areas continues to increase, as discussed above. This had led to the conclusion that "such seduction will not work on the scale which is needed, although individual items on the list might help give short-term partial amelioration for specific crisis situations." (72)

The social, cultural, economic, and political barriers may be just too great to recruit a sufficient number of doctors in conventional and traditional ways. The alternatives to this approach may include required social service for all new physicians; new policies for recruiting students for medical school; or, innovative systems for extending the present manpower supply. The remainder of this study is an evaluation of telemedicine, a prominent example of the latter approach.

3. ISSUES RELATED TO THE USE OF THE PHYSICIAN'S ASSISTANT IN TELEMEDICINE

One effective approach to improving physician utilization of professional time is to allocate certain tasks to medical support personnel, or physician's assistants. In the telemedicine scheme (see Section 1.3) this new role is necessary because the physician does not have direct physical access to the patient, and therefore, is unable to perform all tasks directly, without assistance.* The suggestion that others perform traditional "doctor's tasks" raises many questions regarding the quality of care and general professional and patient reaction to a new type of health care provider. In the evaluation of telemedicine these are of utmost importance because the physician's assistant is the "front line" health care provider, and will be required to make independent decisions in some routine cases, and in the event of system failure. For instance, at least one telemedicine system is reported to have been down almost 3% of total operating time due to voltage cutbacks by the local power company. (80) (See Section 5.4.)

The evaluation of the physician's assistant should be approached from the perspective of how much and how well he can perform when relied upon for independent decision-making and actions. Acceptance of the physician's assistant by the patient and physician is critical because the assistant is a vital component of the system, and failure at any point will have a deleterious effect on the overall health care delivered. The technology may not always function at its optimal level, whereas the patient will always be there.

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*There are some tasks which can be conducted directly between the patient and physician without the physician's assistant. These would include doctor-patient telephone conversations. These interactions are not emphasized in this study.

The term "physician's assistant" will be used in this thesis to collectively include clinically trained professional nurses as well as those health care workers graduated from specific physician's assistant training programs. Names for graduates of specific training programs will be used where deemed necessary.

3.1 TRAINING

The American Medical Association House of Delegates adopted the following working definition of the physician's assistant in December, 1970:

> "A skilled person qualified by academic and practical on-the-job training to provide patient services under the supervision and direction of a licensed physician, who is responsible for the performance of that assistant." (81)

Concurrent with the growth of the concept of "extending the physician" with the physician's assistant has been a proliferation of training programs. However, there is great variation in the programs. The length of study varies from 12 months to 5 years, and the educational settings includes medical schools, medical centers, public and private hospitals, clinics, community colleges, and universities. The prerequisites for admission to the training programs vary from high school graduation to experience as a military corpsman, to possession of a bachelor's degree. The credentials awarded include both certificates and degrees (associate, bachelor's or higher.) (81, 82)

The large variation in backgrounds of physician's assistants is reflected in those chosen for the telemedicine projects in progress.

Available project reports indicate that some of the telemedicine projects have used experienced nurses (3), others have used paraprofessionals (14, 21), and others have used nurses with additional formal training. (81) Some doubt has been raised regarding the advisability of using paraprofessionals, as contrasted with professional nurses. Dr. Kenneth T. Bird, director of the Massachusetts General Hospital Telecenter, believes that "the creation of a new, different hierarchal allied health service personnel such as the physician's assistant,* the MEDEX (former military corpsman with 12-16 months of additional training), and the addition of a mythical medical corpsman to civilian life will dilute the quality of medical care while paradoxically increasing the accessibility." (83) Probably the most significant issue suggested by this statement is the need for determination of just what training and experience the physician's assistant requires to deliver the type of medical care desired in the particular setting. This is not to preclude a generalized background for the physician's assistant, but rather to add to it in the areas where it is most needed. Presently, there is some debate among health professionals over whether the physician's assistant training program should be "general" or "specialized." It seems likely that this issue will be resolved as the role of the physician's assistant becomes better defined.

Available information indicates that great care has been taken in the selection and training of the physician's assistants for the telemedicine projects presently in progress or planned. For example, the telemedicine project intended to improve health care in The Dade County, Florida Penal Institutions is teaching nurses additional primary care skills in its "Primary Care Practitioner Program." This intensive 6 month course concentrates in 3 areas: health maintenance, diagnosis and treatment of minor acute illness, and monitoring of patients with chronic illness. Other telemedicine project directors have chosen nurses whom they had worked with before and whose skills they were acquainted with. Some have relied upon nurses trained in special nurse practitioner programs outside of their own institution. (1) For some purposes, apparently little or no training beyond the technical use of the equipment is required, e.g., assisting in speech therapy, and paraprofessionals or laymen can be used as assistants. (14)

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*Dr. Bird's use of the term "physician's assistant" refers to its non-professional connotation, as contrasted with the use of the term to encompass both the professional nurse and non-professional physician's assistant in this study.

In addition to the obvious necessity of some medical training and a familiarity with the operation of the telecommunications equipment, it may be necessary to instruct the assistant in effective communication behavior to make the interaction with the patient and doctor feel more natural; to train the physician's assistant on the most effective ways for clearly expressing observations to the remote physician; and to perform certain diagnostic procedures that would not normally be taught in a physician's assistant training program but which would be performed by the physician if he was physically present.

3.2 CERTIFICATION

During the past year the issue of guaranteeing a minimal level of training has been partially resolved. (81) In December, 1973, the first proficiency exam was given to candidates for certification as assistants to primary care physicians. The exam was a collaborative effort by the National Board of Medical Examiners, the American Medical

Association, educators in the field, and practicing physician's assistants. Eligibility for participating in the exam was based on graduation from:

(i) A program approved by the AMA Council on Medical Education for training assistants to the primary care physician, or

(ii) A program that has received preliminary approval by the AMA Council on Medical Education for training assistants to the primary care physician, or

(iii) A program that has been funded by the Bureau of Health Resources Development (not included in the above categories) that trains assistants to the primary care physician, or

(iv) A program of at least 4 months duration within a nationally accredited school of medicine or nursing that trains pediatric or family nurse practitioners.

The administrators of the exam expect to expand eligibility to include persons who have acquired proficiency through work experience, contigent upon completion of analysis of the first exam's results. This will allow the utilization of persons with diverse backgrounds while guaranteeing a minimal level of competence.

The AMA has favored certification over licensing because it believes that the latter has not adequately guaranteed the selection of competent health care workers in other allied health occupations. In addition, they feel that licensing tends to impede job advancement and adversely affect innovative uses of new health manpower. (82)

3.3 UTILIZATION

In the telemedicine scheme of health care delivery, devised for doctor-shortage areas, the physician's assistant is the patient's first contact with the health care system. In assuming this role the physician's assistant may fill the gap left by the general practitioner who once represented a visible source of primary medical care in the community, but who is no longer available in certain areas.

Physician's assistants, because of their more varied backgrounds, may be more likely to participate in the delivery of health care in the rural and urban shortage areas than physicians, who are predominantly from other areas and backgrounds. (See Section 2.6.) The physician's assistant's role in health care delivery through a local health clinic in a rural or urban setting offers several distinct advantages over staffing with out-of-the-area medical personnel. Among these advantages are: (25, 45, 46, 77, 84, 85, 86)

(i) A better understanding and higher level of trust between the health care worker and patient due to common socio-economic backgrounds.

(ii) Continuous care from the same health care worker at each visit, should therapy or follow-up be required, because the local health care worker may be less likely to leave the clinic than is a resident, intern, or foreign medical school graduate, at the end of an assigned time period.

(iii) A feeling of allegiance between the health care worker and the community, and thus a greater interest in the patient's personal problems, which may not exist when the doctor comes from outside of the community.

(iv) Job creation for local residents, including nurses and former military corpsman.

Several communities have been served by physician's assistants for many years. The longest established service of this type is the Frontier Nursing Service (FNS), located in the Appalachian Region of Southeastern Kentucky. (86) The FNS nurses are situated at strategically located outposts, none more than one hour from a primary health center (where more comprehensive services are available). The nurses at the outposts, serving 900-1000 persons, are trained to diagnose and manage common health problems and to provide health-related advice to families. A physician visits the outpost at least once a month to review records and check patients with problem cases who cannot get to the hospital. An experimental program, similar to the FNS was initiated by the Department of HEW in a small Minnesota mining town located 25 miles from the closest doctor and hospital. (87) The nurse kept in contact with area physicians for advice and continuous medical training.

The town of Estancia, New Mexico, a doctorless town located in a relatively poor region of the state, has adopted a similar approach. (77) After a clinic facility was built with local and outside funds and no physician could be attracted, it was decided that a local nurse would be given additional clinical training and used to staff the clinic. The nurse has access to X-ray equipment so she can send X-rays to the medical center (by a bus-taxi service) to be interpreted by a radiologist, in addition to a telephone mediated electrocardiographic system. The nurse in the Estancia clinic cannot make decisions which might be considered as "medical diagnosis," rather she looks for abnormal signs and symptoms for the supervising physician to consider. (88) The physician is at the clinic one day per week to check difficult cases and review records, and to allow the physician's assistant to receive further instructions at the medical center. The system in Estancia is somewhere between the primarily independent physician's assistant and the directly supervised physician's assistant.

In summing up the physician's assistant's role in a health care delivery scheme involving a remotely located clinic, the physician's assistant will assume the role of the general practitioner of the past, as the point of entry to the medical care system. This role was summarized as:

> "Every individual should have a personal physician who is the central point for integration and continuity of all medical and medically-related services to his patient.... He will either render, or direct the patient to, whatever services best suit his needs. His concern will be for the patient as a whole and his relationship with the patient must be a continuing one." (89, p. 21)

The level of sophistication of care delivered directly by the physician's assistant will clearly be less than the physician, who will still retain responsibility for the technical aspects of the medical care. The physician's assistant will hopefully play a role which will close the gap, somewhat, between the professional practitioner and the patient. However, it is not at all clear whether the level of care, although better than what may now exist in physician-short areas, will be comparable to health care as traditionally practiced.

3.4 STATUTES ON UTILIZATION

The legal status of the physician's assistant is presently defined by the individual states. As of June, 1973, 33 states had developed some type of legislation regarding the utilization of physician's assistants. (81) In general, the legislation follows one of two approaches: (82, 81)

(i) An exception is made to the state's Medical Practice Act to codify the physician's right to delegate tasks to competent allied health personnel, or

(ii) A broadening of powers is given to the State Board of Medical Examiners so that the board may approve training programs, certify graduates of approved programs, or approve applications submitted by specific physicians for the use of one or two physician's assistants based on a proposed job description by the prospective employer.

The first type of law has been adopted by 6 states, none of which have telemedicine projects. This first approach to regulation has been referred to as the "general delegatory" statute, an example of which appears in the laws of Connecticut (Conn. Gen. Stat. Ann. Sec. 20-9 (1971)) (cited in (81)):

> "The provision of this chapter (Medical Practice Act) shall not apply to...any person rendering services as a physician's trained assistant, a registered nurse, or a licensed practical nurse, if such a service is rendered under the supervision, control, and responsibility of a licensed physician."

The remaining states that have adopted physician's assistant statutes have followed the second approach, which is generally referred to as the "regulatory authority" type of statute. (81) An example is found in the South Dakota laws (South Dakota H674, Regular Session, 1973 New Laws, pp. 89-95). It includes approximately 40 specific activities and procedures which may be performed by the physician's assistant.

The American Medical Association favors a state regulation concerning the utilization of physician's assistants, as contrasted with the traditional (i.e., for other allied health personnel) national non-government, voluntary accrediting agency approach. (90) However, there are special problems created by this approach, when one considers the possible future use of the physician's assistant in the telemedicine scheme. Just as populations are not contained by state lines, medical problems don't respect state lines. There are hospitals in the United States serving populations in adjacent states. This raises the possibility that the state laws of two adjacent states could differ on the utilization or extent of utilization of the physician's assistant, making the activities legal at one end of the telemedicine system and illegal at the other end. This conflict might be resolved by the interstate control (i.e., national) of all physician's assistant-related activities.

The issue of interstate use of physician's assistants via telemedicine systems is directly related to the lack of clear definition of the physician's assistant's role. As explained above, some physician's assistants are allowed to observe, but not diagnose (77), and others are allowed to perform diagnosis of common ailments (86), but, in some states they are prohibited from most types of patient care without supervision by a physician. For example, The Board of Registration in Medicine of the State of New Hampshire regulations pertaining to physician's assistants states:

> "Supervision of a physician's assistant refers to the responsibility of the registered supervisory physician to review findings of a history and physical examination performed by a physician's assistant and all follow-up physical examinations with a physician's assistant together with the patient at the time of the completion of the history and physical examination or follow-up examination; and to consult with the physician's assistant and patient before and after the rendering of procedures, excepting where the rendering of routine laboratory and screening techniques are part of the history and physical examination or follow-up examination performed." (14)

The law excludes the required presence of the physician only "when the physician's assistant attends the chronically ill patient at home, in the nursing home or extended care facility for the sole purpose of collection of data for the information and consideration of the approved registered supervisory physician." (14) The directors of the New Hampshire-Vermont Medical Interactive Television Network interpret these regulations to mean that the tasks performed by their MEDEX in the dermatology clinic would not be legally permissible without television consultation with a physician in every case. (14)

In short, the state laws regulating physician's assistants vary significantly in what they permit and prohibit. Further variation is introduced in the interpretation of the laws. As the use of telemedicine increases, it will become increasingly necessary to define the roles of physician's assistants more precisely, or the possibility of malpractice litigation will be a growing threat. (This is discussed in Section 8.2.)

3.5 THE FOREIGN EXPERIENCE

The use of physician's assistants who exercise independent judgment is a concept relatively new to the United States, but not to many other parts of the world. For hundreds of years the "feldsher," a paramedical worker, has been delivering primary care to the residents of rural areas of the U.S.S.R. Presently, the feldsher is trained for 2 1/2 - 3 1/2 years, at the end of which time he serves a population of about 1,000 people. He performs physical examinations and records medical histories in routine cases, and refers more serious cases to the district hospital, or has them return to the local health clinic at a time when a district physician will be present. (91, 92)

In China, "middle level" health workers delivery primary care to rural areas. The "barefoot doctors" (who actually do wear shoes) receive 3-6 months of medical training followed by continuous on-the-job training. Working from local health stations, the barefoot doctor is responsible for treating light diseases including minor injuries, gastrointestinal illnesses, respiratory infections, and administering immunizations and other public health services. (93)

Several African nations use paramedical personnel in various capacities. Registered nurses in Ghana provide primary patient care for workers in industrial plants, with physicians visiting several times a week from the local hospital. Telephone contact is relied upon at other times. (94) Kenya, Tanzania, Congo, and Ethiopia have all tried various forms of middle-level professional for the delivery of primary care. (95)

In Venezuela the health care system is divided into regions with Health Centers. Each region is divided into 8-10 "Medicaturas Rurales," staffed by general practitioners with special post-graduate training. Communities with less than 2,000 persons are covered by the "Dispensarios Rurales," which are cared for by non-professional auxilaries, physician's assistants trained to diagnose and treat the most frequent and most easily recognizable diseases. (96)

In comparing the use of physician's assistants in other areas of the world to the United States, there are many differences in cultural, social, economic, and political characteristics to be considered. In China there is a significantly different relationship between health care personnel and patients than in the United States. For example, the barefoot doctors are called "comrade," not "doctor," and urban physicians are assigned to periodic tours of duty in the countryside to eliminate "elitism." (93) Obviously, a multitude of political and cultural factors set the climate for this type of relationship. It is also interesting to note that the middle-professional health care workers in other countries (e.g., U.S.S.R.) are given the opportunity for upward career mobility, i.e., they can study to become physicians. This is generally untrue for physician's assistants in the United States.

Even considering all of the differences between the United States and foreign nations, there are several similar problems including:

(i) A concentration of physicians in certain areas.

(ii) An apparent shortage of physicians and medically-related specialists.

(iii) Large rural areas with geographic barriers to travel.

Ultimately, the only differences may be the type of care that the people are accustomed to. For most Americans, the only primary care they have known is that delivered directly by a physician, whereas in foreign countries people are accustomed to non-physician health care providers. Thus, the acceptance of others in the role of health care provider by Americans may be a very difficult barrier to surmount. However, as more doctorless areas continue to appear in rural areas (50), and urban ghetto population-to-doctor ratios continue to grow (55), the attitudes of Americans toward the physician's assistant may change.

3.6 THE LOCAL HEALTH CLINIC

The concept of extending doctors with physician's assistants is intended to make the health care services more accessible to the community by creating a convenient point of entry into the health care system. This is effectively accomplished through the establishment of a local health clinic in close proximity to the population it serves.

Experience with local health clinics of several types has revealed the importance of community involvement in conceiving, locating, establishing, and governing the local health clinic. (45, 77, 97, 98) The necessity for an effective channel of community feedback cannot be emphasized too strongly, because consumer dissatisfaction with policies may mean the services will not be used. (85, 99)

Staffing should, if possible, be done with local persons to maintain a community feeling, create employment, and to build a bond between the patients and the health care system. The use of auxiliary personnel with socio-economic characteristics similar to the patients contributes to this. As Wilson states:

> "It is hoped that the auxiliaries will thereby do more than supply sheer manpower and will, in fact, close the gap between professional treater and lay client and to afford optimal use of leadership and skill in hitherto untapped sectors of the population." (100, p. 46)

3.7 QUALITY OF CARE DELIVERED

The use of physician's assistants in health care delivery schemes which allow some "independent actions" requires a careful assessment of the physician's assistant's abilities. Although each physician's assistant differs, as do individual physicians, it is important to systematically study the outcome of the care they deliver, to develop guidelines for future training programs, certification requirements, and statutes on utilization. Furthermore, the overall quality of the telemedicine scheme relies heavily on the physician's assistant's abilities: technical and non-technical; at least the former can be measured somewhat quantitatively.

General satisfaction with the medical competency of physician's assistants has been expressed by virtually all programs involving such a scheme. (1, 49, 77, 86, 87, 88, 101) The actual level of care quality is difficult to measure, because with the exception of gross errors, differences are often difficult to document. Under the present limitations of "programmed diagnosis," "no diagnosis," or "limited diagnosis" the likelihood of gross errors is significantly less than it would be with "independent diagnosis," because consultation with a physician is likely in most cases that appear to be complex. Although the overall quality of care may be difficult to measure, the components of the overall performance can be monitored. This can be done by keeping clinical records on why the patient came to the clinic, abnormal findings, diagnostic tests, treatment, and follow-up plans. (102) Review of records will, of course, reveal how accurately the physician's assistant has understood the case, and how well the physician's orders have been followed.

Several studies have been conducted to compare the accuracy of physician's assistants and doctors in diagnosing common medical conditions. Kaku, et al. did a comparative study of 4 registered nurses who had received three months of special on-the-job training in physical examination and diagnosis and 7 physicians' observations in the health appraisal of 1,000 apparently well patients. The physicians' examinations were the criteria used for determining the nurses' accuracy. Their results indicated that in 5% of the (16,000) independent variables, the physicians found a sign or symptom that the nurse did not, and in 14.4% of the variables, the nurse found symptoms that the physician didn't find. Apparently, the nurses tended to record findings more completely than physicians did. (103)

In a study by Duncan, et al., the records of children seen by a nurse practitioner, followed by a physician, were compared for 182 children, each having one or more "physical conditions" which included wellness and illness. They observed that the pediatric nurse practitioners and the physicians agreed on their assessment 86% of the time; but only significantly disagreed in 0.7% of the assessments (actually only 2 instances in the entire study.) (104)

Both Duncan, et al. (104) and Kaku, et al. (103) were satisfied with the results that they obtained, and Duncan, et al. stated that the nurse practitioners they studied are "highly competent health professionals in assessing normal and abnormal physical findings in children." (104) Kaku, et al. (103) and others have indicated that larger and more controlled studies are necessary before any generalizations can be made.

Additional studies might include evaluations of each of the several types of physician's assistants to determine which might require more extensive training, or be allowed more independence in actions.

3.8 PHYSICIAN ACCEPTANCE

For the successful operation of a telemedicine system in which a physician's assistant is depended upon, the physician must completely accept the role of the physician's assistant. This is of critical importance because the physician's failure to trust the judgment of the physician's assistant may result in the partial or complete failure of telemedicine to attain its objectives. Specific reasons for failure may include:

(i) Incorrect diagnosis if the physician doesn't fully accept the physician's assistant's physical examination findings.

(ii) Insecurity in the patient, if he senses a feeling of hostility or mistrust between the physician and the physician's assistant.

(iii) Wasteful consumption of valuable professional time if the physician rejects the physician's assistant's history taking and preliminary findings, and proceeds with repeating the same.

(iv) Needless patient travel time if the physician concludes that a face-to-face examination is necessary, because he doesn't trust the physician's assistant's observations, and has no way to verify them, except by in-person examination.

Preliminary empirical observations reveal a high level of trust in the physician's assistant's ability to perform the particular duties assigned in several different situations (including physicians' offices, clinics, hospitals, independent outposts, and in telemedicine systems.) However, the doctors making these observations are a limited, select group, specifically involved in and interested in seeing the use of physician's assistants be proven feasible. It is the majority of doctors, who are not presently working with physician's assistants. who may be the key to widespread acceptance or rejection.

Traditionally, doctors and nurses have had a very special relationship. Stein has characterized this as "The Doctor-Nurse Game," in which the doctor makes the decisions and the nurse is expected to "subtly" communicate her recommendations, without appearing to be making a recommendation statement. (105) This pattern develops as early as the selection of students for both nursing (107) and medicine (105, 106), and is ingrained throughout the training process. The result is a seemingly "mutual respect and cooperation," which is actually quite one-sided. As other disciplines have entered the "medical world," problems have arisen as physicians expected engineers and technicians to assume the same passive roles as the nurses. (105, 108) Considering the attitude along with the general characteristics of the medical profession, e.g. conservatism, autonomy, possession of final medical responsibility (68, 84, 108, 109, 110, 111), one would expect resistance to the acceptance of the physician's assistant from the medical establishment.

Perhaps due to changes in attitudes (e.g., trend towards group practice and development of the "medical team" approach) or the necessity for assistance because of overwork, physicians are beginning to accept the role of the physician's assistant in some health care settings. A survey of California pediatricians by Schoen, et al. revealed that the respondents were receptive to the use of pediatric nurse practitioners. The doctors were willing to delegate certain tasks, but hesitated to allow the nurses to function with much independence in direct patient care. Some physicians expressed strong disagreement with the reality of "the manpower crisis" (see Chapter 2) and showed concern that use of physician's assistants would result in a decrease in the quality of care, and the possibility of developing a "second-class M.D." In this study, 80% of the respondents agreed that pediatric nurse practitioners might be best utilized in areas with health care shortages, yet only 3% of the pediatricians characterized their own practice as rural. (116)

This raises a very significant point: the physician's assistant may pose somewhat of a threat to a physician practicing in an area with no apparent health care shortage but probably would be received better by an overworked doctor in a shortage area. This has, in fact, been shown in all of the reported cases of physician's assistants practicing at locations remote from the physician. (1, 77, 86)

As the use of telemedicine expands in the future and as telemedicine systems appear in more areas, a larger number of physicians involved in telemedicine will be needed to deliver the health care services. This will require a wide-scale acceptance of the physician's assistant for telemedicine to be deemed feasible. A direct effort should probably be made to document the effectiveness of the physician's assistant to be used in convincing physicians to accept this new role in health care.

3.9 PATIENT ACCEPTANCE

Acceptance of the physician's assistant by the patient may be one of the major components of the overall acceptance of telemedicine. Considering the great importance of the patient's reaction to the physician's assistant, very little systematic study of the area has been conducted. Patterson, et al. have studied the feelings of mothers who had brought their child to a private pediatrician, group health, or public well-baby clinic.* Three quarters of the mothers approved the concept of a pediatric assistant for well-baby care in the doctor's office, and 94% were willing to try it. In addition, they found that the mothers from varied socio-economic classes and backgrounds would approve of the use of the pediatric assistants for well-child care "if their physicians deemed it necessary, if it would increase availability of services to others, if the program were appropriately introduced, if waiting time was reduced, and if the assistants proved to be "well-trained," confident, and capable of imparting worthwhile advice on routine matters." (112)

Smith and O'Donovan's study of the practice nurse in a semi-rural area in England with 3 general practitioners serving 9,000 patients found a positive public response to the use of nurses going to the patients' homes for primary screening. They observed a shift in attitudes towards certain services which the nurse should be allowed to perform, over a period of time. (109) A similar phenomenon was observed by Lewis and Resnik in a study of two groups of patients, in an urban area in the United States, one receiving all care from a doctor and the other from a nurse. They observed that the group served by the nurse showed a higher rate of satisfaction with the care they received. (113) Lees and Anderson have found that patients are most willing to allow nurse assistants to perform activities which are technical in nature, as contrasted with those that require judgment and decision-making. Their study, conducted in Canada, indicates that the population they studied rejected the nurse in a counseling or diagnostic role. (114) This may be similar to the rejection of the physician's assistant by physicians from non-shortage areas. Patients living in areas which do not suffer from extreme health care resources shortages may be less likely to accept the physician's assistant in a broad capacity, whereas persons living in areas with rather limited health care resources may more readily accept this new role.

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*Well-baby clinics are utilized to screen healthy babies for medical conditions, to allow a preventive approach to medical care.

Reaction to the physician's assistant in health care-shortage areas has not been studied extensively. In most of these areas the patients are given little choice of where they obtain their health care. Either they accept the care offered locally or travel somewhere else to get it. A study conducted near the Johns Hopkins School of Medicine in Baltimore revealed that 85% of the ghetto population living there was willing to accept a physician's assistant for their primary medical examination. (115) However, it is extremely difficult to differentiate the role of factors such as the lack of choices available from the other factors combining to form this rather positive attitude towards the physician's assistant. Another study found that lower middle-class and working-class patients do not accept care from physician's assistants as well as do upper middle-class patients. (116) The basis for these seemingly contradictory results is not clear.

Edwards and Lindsey have reported a study conducted in Cambridge and Midvale, Idaho, communities served by a physician's assistant. Their random sampling of area residents indicated that 48% had gone to the physician's assistant for treatment during the preceding year; 27% had travelled to see a medical doctor at the local hospital; 35% had gone out of the area to see a medical doctor; and 3% had seen an osteopath or chiropractor for care. Thus, given a choice between travelling a distance and seeing a local physician's assistant, the residents frequently chose the latter. (49) Similar results have been realized in Estancia, New Mexico, where one of the medical consultants who advises the physician's assistant commented that, "We see persons from all spectra of life, ranging from the bank president and his family, who use the clinic extensively, to some of the county's rural poor." The alternative is to travel 60 miles to Albuquerque for medical care (88).

A report of the New Hampshire-Vermont Medical Interactive Television Network (14) indicated that 91% of the patients were "very satisfied," while the remaining 9% were "somewhat satisfied" with the physician's assistant's demeanor towards the patient and his apparent competency. However, as stated above, the directors of this project have interpreted the New Hampshire State Laws to require a physician's supervision (by telemedicine in this case) for all patients, i.e., no case can be disposed of without a physician consultation. Therefore, although these results are encouraging, they do not confirm the patient's acceptance of a physician's assistant who makes independent decisions, as other projects allow.

If health care providers expect to measure accurately the patient's acceptance of the physician's assistant, they are going to have to administer more comprehensive studies, which do not only query reactions or anticipated reactions to the physician's assistant, but, which also allow the respondents to indicate a comparison of their reactions to the physician's assistant and other alternatives, e.g., travelling some distance to obtain health care. These surveys may serve a purpose beyond simple public knowledge; they may reveal the existence of barriers to the institution of the presently conceived telemedicine scheme, which depends heavily on the acceptance of the physician's assistant for certain types of medical tasks in certain situations. These situations and the appropriate tasks still remain to be determined.

4. TELECOMMUNICATIONS AND MEDICINE: A BRIEF OVERVIEW

Traditionally, health care delivery has employed three systems for communication: face-to-face contact, electronic audio-communications, and written or printed information exchange. (31)

Face-to-face interaction has been the most frequently used, as almost all communication between doctor and patient is conducted this way. Transmission of information between administrator and doctor, and between doctors, is often accomplished face-to-face, at medical conferences, or frequently in casual conversation within the hospital.

Communication via audio electronic systems is frequently used for doctor-patient communication at the onset of an illness and for administrative purposes, including appointment-making, checking on test or examination results, and calling emergency services. The audio mode has also been used to exchange medical information between doctors and other health care personnel, and on the battlefield between medics and the area hospital. Miniaturized audio receivers are frequently used to page physicians and other health care personnel both inside and outside of health care institutions.

Written or printed information exchange is most frequently used to disseminate professional information (e.g., research findings) among doctors and other health professionals. Written communication is almost nonexistent between doctor and patient, and, as Williams points out, is sometimes actively prevented by the physician writing "illegible" prescriptions, so that the patient cannot read them. (31)

The transition from the use of audio and written communications for limited medical tasks to the rather extensive use of audio and video telecommunications for direct patient care has occurred rapidly in recent years. This chapter briefly reviews the progression of medical communications from the simplest to the most sophisticated systems, and is presented to establish the background necessary for understanding the development of telemedicine.

4.1 BRIEF HISTORY OF COMMUNICATIONS IN HEALTH CARE

Ever since the first medical practitioner met the first patient many years ago, the frequency of contact and the content of medical information exchange have been increasing. Concurrent with industrialization and technological advances, the character of medical information exchange has been changing.

The introduction of writing and printing made it possible to transmit messages and record them for use in future generations. The advent of the telephone made it possible for two or more persons at physically separate locations to substitute electronically mediated audio communication for face-to-face communication which would have required travel to a common location. The invention of wireless communication allowed the participants in the electronically mediated communication to be more mobile, because there was no longer a necessity for wires to connect them. The use of wireless communications in health care was most commonly found on the battlefields during war, to connect the field medic to the physician, and in public health outposts in isolated areas to allow contact between public health nurses and other health professionals. (48) In recent years a similar scheme has been used in rural clinics to provide physician consultations at all times. (77, 117)

4.1.1 Physician-Patient Communication and Patient Monitoring

The uses of communications discussed above primarily involve an exchange of information between health care providers regarding the patient. In addition to this type scheme, many examples of communication directly between physician and patient have been demonstrated. Among the earliest electronically mediated communication between doctor and patient was the exchange of information via the telephone. A more recent type of communication from the patient to the doctor is the transmission of physiological data. This usually occurs within hospitals, when it is deemed advisable to monitor critically ill patients constantly. Various telemetry systems have been developed to constantly display physiological signs, including electrocardiograms (EKG), respiration rates, and blood pressures at centralized locations, allowing a single person to simultaneously monitor several patients. As the technology has improved, it has become apparent that direct monitoring of patients in ambulances and other mobile medical units would be very beneficial, because it would allow a rapid initiation of therapy, and allow the hospital-based physician to be familiar with the patient's condition before he reached the hospital. (118-121)* Some localities have purchased mobile units which compare to emergency rooms, capable of two-way radio contact with hospitals. (122) NASA has recently become involved in the development of portable "Telecare" units which provide the capability for remote monitoring of EKG, EEG, and blood pressure to allow rapid diagnosis and early treatment on emergency calls. (33)

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*An electronics magazine reports that since action in the first 30 minutes generally determines whether an injury or heart attack victim lives or dies, prompt care, coupled with continuous supervision, is likely to save 20-25% of the annual U.S. heart attack victims. (123)

In addition to the systems designed to monitor physiological signs, television monitoring systems have been installed in many hospital intensive care units to allow the nurses viewing the monitors to watch the patients directly. The capability to transmit television signals from the mobile units presently exists, giving the hospital-based physician the opportunity to view his patient en route to the hospital. However, the cost factor and the difficulty in securing frequencies may prevent the wide-scale use of television in mobile units in the near future. (122, 123) Considering the fact that less than 10% of U.S. hospitals are presently able to communicate directly with ambulances, it may be that the persons responsible for these devices are not really convinced that the benefits of communication en route to the hospital justify the costs. (122)

Mobile medical communications have also been applied to patients requiring occasional monitoring, without hospitalization. In these cases, the patient relies upon a telephone coupler to transmit a physiological signal from his home to his doctor's office or a hospital. Patients with cardiac pacemakers have recently become able to have their heart monitored via this scheme by connecting an electronic coupler to any telephone. (124) In other settings, clinics can directly transmit electrocardiograms to a central medical facility for computer diagnosis, supervised by specialists. (125)

4.1.2 Communications and Education

Among the broadest applications of electronically mediated communication in medicine has been the education of patients, physicians, and other health care workers. The range of educational programs has been large and varied, tailored to meet the needs of the particular audience.

Perhaps the earliest educational broadcasts were the broadcasts of intricate surgical procedures, to allow medical staffs and medical students to see things that would otherwise be impossible to observe. Albany Medical College began broadcasting educational programs to physicians across the Northeastern United States more than 15 years ago. Live radio broadcasts on a variety of medical subjects, conducted by medical specialists who are connected to the central studio by radio, are presently sent to health professionals in at least 72 hospitals. The audience is able to respond via a two-way radio network. (126) Other medical communications networks have been developed which can broadcast programs directly to physicians' homes (e.g., The Louisiana Hospital Network (33)), directly to hospitals (e.g., The Georgia Regional Medical Television Network, and the Veterans Administration Network-St. Louis (127)), and between medical centers for teaching, training, consultation, and administration (e.g., The University of Kansas Medical Center (33), The Nebraska Psychiatric Institute-Norfolk State Hospital (20), and The New Hampshire-Vermont Interactive Medical Television Network (128)).

Other medical institutions have developed tape libraries (e.g., The University of Wisconsin "Dial-Access System" (129) and The University of Missouri Audio Message Center (130)) which allow physicians to dial a particular telephone number to receive specific information on a particular medical condition. The Medical Society of Erie Couny, New York, has established a similar service for patients. (131) The University of Missouri has also developed a Telelecture System for broadcasting medical lectures to hospitals across the state. (130) One of the pioneers in this field has been the Massachusetts General Hospital-Bedford VA Hospital system, which is used regularly for the exchange of medical information of a wide variety. (3) (See Table 7.)

The Lister Hill Center for Biomedical Communications, an element of the National Library of Medicine, was established by Congress in 1966 to serve as the focal point for the coordination of biomedical communications and network projects for the Department of HEW. Among the projects developed to date are the "Medline" and "Medlars" systems which enable libraries throughout the United States to retrieve biomedical communications on-line from a central source. (129, 132) The Lister Hill Center is presently involved in several telemedicine projects including the Alaska Health Care Experiment (using NASA's ATS-1 and ATS-F satellites), The Regionalized Medical School, The New Hampshire-Vermont Interactive Medical Television Network, and the Mt. Sinai School of Medicine geriatric housing project experiment. (The patient-care aspects of these projects are discussed in Chapter 5.)

Presently NASA, HEW, and The Corporation for Public Broadcasting are involved in the Health/Education Telecommunications Experiment which includes several programs. Among these is the Veterans Administration project which includes experiments with computer assisted instruction for continuing medical education, transmission of medical seminars, the training of paramedics, and community health education. The Applied Technology Satellite (ATS-F) will be used for the transmission of interactive programming in this project.

A second project is the "Regionalized Medical School", which will "apply interactive audio, data, and television to the solution of problems encountered in providing basic science education to students remotely located from the medical school." (13) Programming will be transmitted between the University of Washington Medical School and medical students in Fairbanks, Alaska and Omak, Washington via NASA's ATS-F satellite. Interactive television will be used to teach basic science courses, provide administrative conferencing between officials, allow counseling of students, and for computer evaluation of the medical students' progress in certain areas. "The purpose of the experiment is to determine how satellite communications could cost-effectively contribute to the following: increase medical school enrollment; contain the cost of medical education; provide meaningful educational experience in non-metropolital communities; increase flow of knowledge between community practitioners and the university; and, broaden educational opportunities in the medical subdisciplines by providing opportunities to study in communities under physician teachers." (13) It is hoped that in the long run communications satellites will provide telecommunications linkages between medical centers and remote areas which would allow the establishment of residency training centers in these areas, the broadcasting of continuing education programs for health workers, and the establishment of more two-year basic science medical schools. (13)

Medical education for the patient has traditionally been unidirectional. Patients have received health education through public health films and lectures. Recently, several hospitals have begun programming material on specific medical problems for hospitalized patients. For example, St. Nicholas Hospital (Sheboygen, Wisconsin) and Holy Ghost Hospital (Cambridge, Massachusetts) have sent closed circuit television programs to patients' rooms. (33) In recent years television shows in several parts of the United States have been broadcast live to allow viewers to telephone-in questions. Some hospitals have also experimented with this type of scheme on their closed circuit television systems.

The realization that health items comprise only a very small portion of the week's television time has prompted the Children's Television Workshop (of "Sesame Street" fame) to produce a series of programs on health, scheduled for broadcast on ABC television in Fall 1974. It is hoped that the "education-plus" entertainment format of these shows will convey health information to persons whose access to practical information is often scant. (133)

The Department of Community Medicine of the Mt. Sinai School of Medicine has recently established an innovative system for patient health education in New York City. A housing project for the elderly has been wired with a cable television system capable of bi-directional (two-way television) wide-band transmissions. Presently it is being used to broadcast community, health, safety, and nutritional programs to the apartments in the housing project. In the future the audio and video return channels will be utilized for interactive programming. (28, 134)

The range of communications utilization in health care delivery has been broad and constantly expanding. In some applications it has proven to be clearly beneficial; in others the overall cost/benefits are still not known. In any case, it appears likely that these types of communications experiments in medicine will continue to expand in the future. A more complete discussion of this topic can be found in Konrad Kalba's report to the Sloan Commission, Communicable Medicine: Cable Television and Health Services (30) and the report by ABT Associates, Telecommunications and Health Services. (33)

4.2 USE OF COMMUNICATIONS IN HEALTH CARE

The expanded use of communications in medicine in recent years has clearly demonstrated that some health care services can be improved through this approach. As the technologies become more refined and available, people look towards the future for continued growth in the same direction. Although it is difficult to predict the futures of specific technologies with high accuracy, several notable attempts have been reported. Doyle & Goodwill (cited in (31)), McLaughlin (cited in 31)), and Martino (135) have used the Delphi technique to forecast the future use of communications technology in medicine.* The Delphi technique involves the sampling of experts in the field regarding their opinions of the probability and time-span of future developments. The experts are asked to do this two or three times, and are given feedback from the group after each round. Eventually some sort of consensus forms among the group. Robinson has discussed some of the limitations of the Delphi method. (136)

The experts participating in these Delphi Studies forecast the expanded use of electronic systems for diagnosis at remote locations, remote monitoring of patients (by doctor and/or computer), remote treatment by doctors, computer medical history-taking, computer psychological testing, computer-aided diagnosis and treatment, teleconsultation, expanded education by telecommunications, computerized record-keeping, and computerized medical libraries. (31, 135) In addition, one can expect an expanded use of multi-phasic health screening, a process of screening large populations with medical tests and examinations to sort out individuals with obvious deviations from the norm of the population. This will be made possible by the connection of mobile health screening teams to central medical facilities. This will enable the teams to go to the population that they are screening, while having the capacity to transmit their findings to the central medical facility. (137, 138)

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*The Martino forecast (135) covered the years 1968-2000. Unfortunately, the results of the Doyle and Goodwill study and the McLaughlin study were only available in summary form in Williams' paper (31) and the exact range of the forecasts are unknown to this author. Nevertheless, the three studies are presented to indicate the general feeling among experts regarding the future use of communications in medicine.

In the past, most of the applications of communications technology in health care delivery have involved either:

(i) Communication between health professionals about the patient, or

(ii) The transmission of physiological signals.

The majority of applications of communications forecast for the future rely more directly on the man-machine interface than many of the previous ones did. Specifically, health care systems using computers for direct patient care and schemes involving electronically mediated communication between doctor and patient introduce the potential for new social problems, many of which we have never been faced with before. The future of communications in medicine probably depends upon the development of an understanding of these problems, and a willingness to admit limitations as they are realized, so that they can be effectively dealt with.

5. TELEMEDICINE PROJECTS

During the past ten years at least 18 telemedicine projects have been conducted and at least six others are presently in the planning stages. This chapter describes the telemedicine projects in terms of the specific problems approached, the types of equipment used, the factors involved in the design and construction of systems, the costs, and the role of industry in the field of telemedicine. Evaluations of the projects are discussed in Chapter 6.

5.1 SPECIFIC PROBLEMS APPROACHED BY TELEMEDICINE PROJECTS

The telemedicine projects have included a broad range of locations, populations served, and specific purposes. Table 6 indicates the types of populations served by each project and the year of project inception. Table 7 lists the large variety of telemedicine transactions performed via the Massachusetts General Hospital-Bedford VA telemedicine link, and Table 8 summarizes the types of services available in all of the projects. Although great diversity exists among the telemedicine projects, all of them are primarily concerned with several basic problems, including:

(i) Evaluating the quality of medical care delivered via telemedicine.

(ii) Examining the effects of telemedicine on available professional time.

(iii) Weighing the costs of telemedicine in comparison to possible alternatives.

(iv) Determining the optimal and most appropriate technologies to employ for the best technical and

Table 6. Telemedicine Projects: Populations Served And Dates Projects Became Operational

	Year Project Began Operation	Population Served				Reference
		Rural	Urban	Nursing Home/or Prison	In-Hospital	
MGH-Logan	1968		x			(2, 3)
MGH-Bedford	1970				x	(2, 3)
Lakeview	1973	x			x	(4)
Harlem-Mt. Sinai	1972		x			(5)
Bethany/Garfield	1972		x		x	(6, 7, 139)
Case Western Res.	1972				x	(8)
Illinois Mental H.	1972		x			(9, 139)
Cambridge Hospital	1972 (a)		x			(139)
Blue Hill, Me.	1973	x				(1)
STARPAHC (e)	1975 (b)	x				(11, 140)
Alaska-ATS-F (e)	(d)	x				(13)
Veterans Admin. (e)	(d)	x				(13)
New Hampshire/Vt.	1968 (c)	x				(14)
Nebraska Radiology	1973	x				(15, 139)
Florida Penal Inst.	1974			x		(16, 17)
CTS (e)	1975 (b)	x				(18)
Nebraska VA	1964				x	(20)
Farmington, Me.	1971	x				(21)
Ohio Valley	1969	x				(22)
Puerto Rico (e)	(d)	x				(23)
Jacksonville	(d)					
Cook County Hosp.	(d)				x	(24)
Arizona Network (e)	(d)	x				(25)
Boston City Hosp.	1973			x		(26)

(a) Project terminated.

(b) Projected date.

(c) Reports indicate that the initial two-hospital link became operational in 1968. In 1972, the system was expanded considerably to include several other locations, hence the present name, New Hampshire-Vermont Medical Interactive Television Network.

(d) Information not available.

(e) Not yet operational.

Table 7. VAH Bedford Telemedicine: Categories of Transactions.* From Reference (27)

- ALCOHOL TREATMENT UNIT
  - With patients
  - With staff
- PSYCHIATRIC EXAMINATIONS
  - With patients
  - By HMS students
- PSYCHIATRIC PRESENTATIONS
  - For HMS students
- MEDICAL CONSULTATIONS
  - Internal medicine
  - Cardiology
  - Other specialists
- DIETICIAN
  - Student orientation
  - Lectures and discussions
- SPEECH THERAPY
  - Evaluation of patient
  - Individual treatment
  - Group treatment
  - Staff training
- PROFESSIONAL REVIEW COURSES
  - Psychiatry Board
  - Neurology Board
  - Immunology
  - Problem Oriented Medical Record
- SEMINARS
  - Medical
  - Drug
  - Headache
- PSYCHODRAMA
  - With patients
  - With staff
  - Trainee teaching
- HYPNOTHERAPY
  - Individual
  - Group
- VIETNAM VETERANS
  - Group therapy
  - Individual therapy
  - Speech therapy
- GRAND ROUNDS
  - Medical
  - Psychiatric
- NURSING SERVICES
  - Discussions
  - Seminars
- CLINICOPATHOLOGIC CONFERENCES
  - Professional staff
  - Students
- SOCIAL SERVICE
  - VARO meetings
  - Community placement
  - Patient screening
  - Community resources
  - Information review
  - Teaching
- COUPLES THERAPY
  - Couples
  - Couples with children
  - Staff training
- DRUG UNIT
  - Group therapy
  - Patient conferences
  - Staff conference

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*A transaction is a real-time informed consent health information exchange via confidential telemedicine circuitry. From the point of view of the patient a transaction may occur with a physician, a nurse, a human care professional or allied health service personnel, an administrator, an advocate or any other type of health care provider.

Table 7. VAH Bedford Telemedicine: Categories of Transactions. From Reference (27). (continued)

DERMATOLOGY
- Consultation
- Teaching staff
- Teaching Harvard Medical School (HMS) students

DRUG ABUSE DISCUSSIONS
- Staff nurses
- Student nurses

COLLOQUIUM
- Learning disabilities

STAFF CONFERENCES
- Alcohol Unit
- Drug Unit
- Day Care Center
- Ward team

TEACHING TAPES/INTERACTION
- Luncheon seminars
- Nurse cardiac workshops
- Headache seminar

Table 8. Telemedicine Projects: Services Available

	Diagnosis and Consultation	Therapy (a)	Specialist Consultation	Laboratory Tests	Radiology	In-Hospital Patient Observation	Prescription or Record Transmission	Administration	Public Health Education	Medical Education	Other	Reference
MGH-Logan	x	x	x	x			x			x		(2, 3)
MGH-Bedford	x	x	x			x		x	x	x		(2, 3, 141)
Lakeview	x	x	x			x						(4)
Harlem-Mt. Sinai	x	x	x						x	x		(5, 28)
Bethany/Garfield	x	x	x	x			x				x(b)	(6, 7)
Case Western Res.	x		x			x	x				x(c)	(8)
Illinois Mental H.	x	x						x		x		(9)
Cambridge Hospital (d)	x	x										(10)
Blue Hill, Me.	x	x						x	x			(1)
STARPAHC (e)	x	x	x	x	x		x	x		x		(11, 140)
Alaska-ATS-F (e)	x	x						x	x	x		(13)
Veterans Admin. (e)	x	x	x			x			x	x		(13)
New Hampshire/Vt.	x	x	x			x			x	x		(14, 142)
Nebraska Radiology	x				x							(139)
Florida Penal Inst.	x	x					x					(16, 17)
CTS (e)	x	x	x		x				x	x		(18)
Nebraska VA	x	x	x			x				x		(20)
Farmington, Me.	x	x		x	x			x				(21)
Ohio Valley	x	x	x							x		(22)
Puerto Rico (e)	x	x	x	x	x		x	x		x		(23)
Jacksonville	x											(143)
Cook County Hosp.	x	x	x		x	x		x				(24)
Arizona Network (e)	x	x	x	x	x		x					(25)
Boston City Hosp.	x	x	x				x					(26)

(a) Includes psychiatry, speech therapy, and others. (b) Supervision of pharmacist technician.

(c) Supervision of nurse anesthetist. (d) Project terminated. (e) Not yet operational.

most accurate results.

(v) Seeking to find the most beneficial and efficient combination of staff training, experience, and technology.

(vi) Monitoring the interpersonal factors between staff members and patients, which may affect the telemedicine transaction.

Perhaps the earliest telemedicine project dates back to 1964 when the Nebraska Psychiatric Institute in Omaha, Nebraska and the Norfolk State Mental Hospital, located 118 miles away, were linked together via a two-way video system. Their use of the telemedicine system included psychiatric diagnosis and consultation, televised patient visits, personnel training, and joint research projects. (20)

Four years later the Massachusetts General Hospital-Logan Airport system was instituted to provide care for general medical problems at the Logan Airport Medical Station. Equipment for measuring and transmitting physiological data was installed to provide a complete picture of the patient's medical condition for the doctor at the hospital. In the Massachusetts General Hospital-Logan Airport scheme, a nurse clinician is stationed at the airport medical station to perform preliminary assessments of patients and to provide care for minor, routine problems. The Massachusetts General Hospital Telecenter, directed by Dr. Kenneth T. Bird, has expanded its services vastly over the six years since its inception, and presently includes telemedicine links to several sites within the Massachusetts General Hospital and to the Bedford VA Hospital and The Shriners Burns Institute. (27) The Massachusetts General Hospital Telecenter's telemedicine projects have been, by far, the most comprehensive projects performed, both in depth and breadth. They presently provide a large number of services to the people inside and outside of several hospitals in the Boston area. (See Tables 7 and 8.) (3, 141, 144) The five-hospital Ohio Valley Medical Microwave Television System is similarly involved in a broad range of experiments including teleconsultations and medical education. The population they serve includes the inhabitants of the rural poverty areas of Southeastern Ohio, i.e., Appalachia. (22)

Other groups have selected more specific problems or geographic areas for their studies of telemedicine. Gravenstein, et al., of Case Western Reserve University, have chosen to study the supervision of a nurse anesthetist by an anesthesiologist via telemedicine. Normally, the nurse anesthetist works unsupervised, due to the geographic maldistribution of physician anesthesiologists. This experiment seeks to improve the quality of care by adding the additional expertise of a specialist to an existing situation. (8) The Nebraska Radiology Experiment, directed by **Wilson**, similarly examines the effect of the addition of a specialist's services to an area previously functioning without them. In this case, a radiologist in Omaha will be interpreting X-rays transmitted from Broken Bow, Nebraska, a small rural community. (139) The New Hampshire-Vermont Interactive Medical Television Network has studied the use of telemedicine for dermatology, speech therapy, and other medical specialties for community hospitals lacking them. In this case, medical specialists and medically-related specialists are able to cover a broader geographic area. (14)

5.1.1 Urban Projects

Some telemedicine projects have approached specific geographic and demographic groups by instituting the system most apt to serve them best. The Bethany-Garfield Community Health Care Network has been established to join two hospitals, three health clinics, three drug clinics, and a clinic served by a private physician, all located within a predominantly poor urban ghetto. The decentralization of these facilities has often created many problems related to the flow of information (administrative and medical) between facilities. The telecommunications equipment installed in the Bethany-Garfield Community Health Care Network (including Bell Picturephones and two-way black and white television systems) is designed to allow physicians, pharmacists, and administrators better access to the dispersed facilities. It is hoped that administrators will be able to maintain better control over the facilities, physicians will be able to locate medical records and obtain specialist consultations more easily and rapidly, pharmacists will be able to supervise two laboratories simultaneously, and that laboratory and patient records will be more rapidly transmitted between locations. (7)

Also within the city of Chicago, the Illinois Psychiatric Institute has connected its three hospitals and three community outposts by Bell Picturephones. The three outposts, staffed by paraprofessional personnel from the neighborhoods and Department of Mental Health, function as screening, linking, and treatment facilities. Patients are evaluated at the outposts, and whenever possible treated there, but many patients must be referred to the large Institutes for back-up services. In the past there had been significant difficulties in communication between the staff at various levels and locations. The Picturephone network has been installed to improve the coordination between the outpost clinics and the in-patient and specialized services, provide professional advice at all locations, facilitate movement of patients from one service component to another, and encourage staff consultation and information exchange. (9)

In New York City, The Department of Community Medicine of The Mt. Sinai School of Medicine is studying the feasibility of substituting bi-directional television for face-to-face and telephone-only contact. The telemedicine link connects a child health clinic in a Harlem housing project to the Mt. Sinai Medical Center. If the telemedicine link did not exist the remote clinic would have to rely on telephone-only communication. Although the two facilities are only one and one-half miles apart, in an urban ghetto this represents a barrier to those seeking care. The Department of Community Medicine hopes to demonstrate that many medical problems can be treated in lieu of travelling by either doctor or patient. In the initial phase of the project pediatricians, psychiatrists, and orthopedic surgeons have utilized the system to provide specialist services that were previously unavailable to the clinic. (5, 28)

The Cambridge (Massachusetts) Hospital project has also studied the use of telemedicine between a hospital and urban clinics, but has approached several other aspects of the problems faced in this setting. Their evaluation of telemedicine included a comparison of telephone and interactive television in regard to time required for particular tasks, and a preliminary cost analysis of personnel and technology combinations. (10)

5.1.2 Prison and Nursing Home Projects

In a situation similar to both rural and urban remote areas, prison populations are often restricted by barriers (physical and administrative) from obtaining the care they need. The Florida Penal Institutions are studying the effect of telemedicine on that situation, and hope to evaluate various technologies. A major objective of their program is the evaluation of the training and utilization of the physician's assistant in telemedicine. (16, 17)

Nursing homes, like prisons, are often removed from the mainstream of health care services, and telemedicine may promise improved care for patients in these institutions. To cut down on unnecessary and costly Emergency Room visits, the Boston (Massachusetts) City Hospital employs a telephone, a facsimile copier and a portable EKG machine to connect physician's assistants in nursing homes to a physician in the Boston City Hospital. Presently, several hundred patients in twelve nursing homes are given 24-hour medical coverage this way. (26)

5.1.3 Rural Projects

Telemedicine is likely to be used frequently in isolated rural areas in the future. Its function, as described above, will be to support either a rural physician or physician's assistant. Wempner, et al. of the Lakeview Clinic in Waconia, Minnesota have studied the role of telemedicine in assisting rural physicians to deliver more effective care. Specifically, they were studying how telemedicine might improve traditional telephone-only communication, save time for physicians and patients normally spent in needless travel between facilities, and make physician's services more available in the area. (4) In the same region of Minnesota the Chaska School System utilizes a closed circuit television for professional nurses to maintain contact with nurse assistants. This arrangement enables the schools to have professional qualtiy nursing care in all schools, which would otherwise be impossible due to a shortage of professional nurses in the area. (145)

In another rural setting, the Blue Hill-Stonington, Maine interactive television system connects the small coastal town of Stonington, Maine (population 1,300) to the nearest sizable community, Blue Hill, over 30 miles away. The 60 mile (round trip) had often been an insurmountable barrier to persons requiring medical care, a situation which the telemedicine system is helping to overcome. (1) Rural Health Associates of Farmington, Maine are presently staffing their remote clinics with physicians's assistants during most of the hours when doctors are unable to be present. The telemedicine system clearly improves the quality of care that would otherwise be available. (21)

Several other telemedicine projects for the delivery of care to isolated rural areas are planned. STARPAHC (Space Technology Applied to Papago Area Health Care), a joint effort by NASA and the Indian Health Service, is "a system designed to study the impact of a new technology upon a health system to increase quantity and quality of care for a rural population..." and "to provide a test site for the development of future health care technology to support groups of humans in a remote colony, for example, in the permanent Earth Satellite space station now in the planning stage." (12) The STARPAHC system will aid in the delivery of care to the Papago Indian reservation in Arizona by linking a health center and mobile van clinics to a primary care hospital. (See

Figure 3.) In addition to STARPAHC, there is also a state-wide plan for health care delivery on the Indian reservations in Arizona, called the Arizona Telemedicine Network. The Network will utilize physician's assistants ("Community Health Medic") to delivery primary care by connecting them to area and regional facilities for medical supervision and consultation. Of major importance in The Arizona Network are the establishment of an optimal communication configuration for specific medical tasks; assessment of patient and user attitudes towards the system; measurement of the quality of care; and determination of cost-effectiveness of the system. (25)

Space technology will be utilized in the Communication Technology Satellite (CTS) (18), the Alaskan Health Experiment (13), and the Veterans Administration (13) projects. The CTS project will study the use of telemedicine via satellites for continuing medical education, community health programs, and medical specialist consultation services throughout the U.S. and Canada. It is anticipated that the availability of telecommunications links will reduce needless travel by patients from remote areas to specialists in more populated areas, ease the isolation of northern Canadian residents transported south for treatment, and lessen the isolation of health personnel in remote areas. (18) The Alaskan Health Experiment will be concerned with the evaluation of the effectiveness of telemedicine via NASA's ATS-F satellite in assisting physicians in providing supervision and guidance as well as consultative and diagnostic support to Alaskan village aides and medics. Other objectives of the program include the determination of the optimum mix of biomedical and video equipment for use by health care providers with different

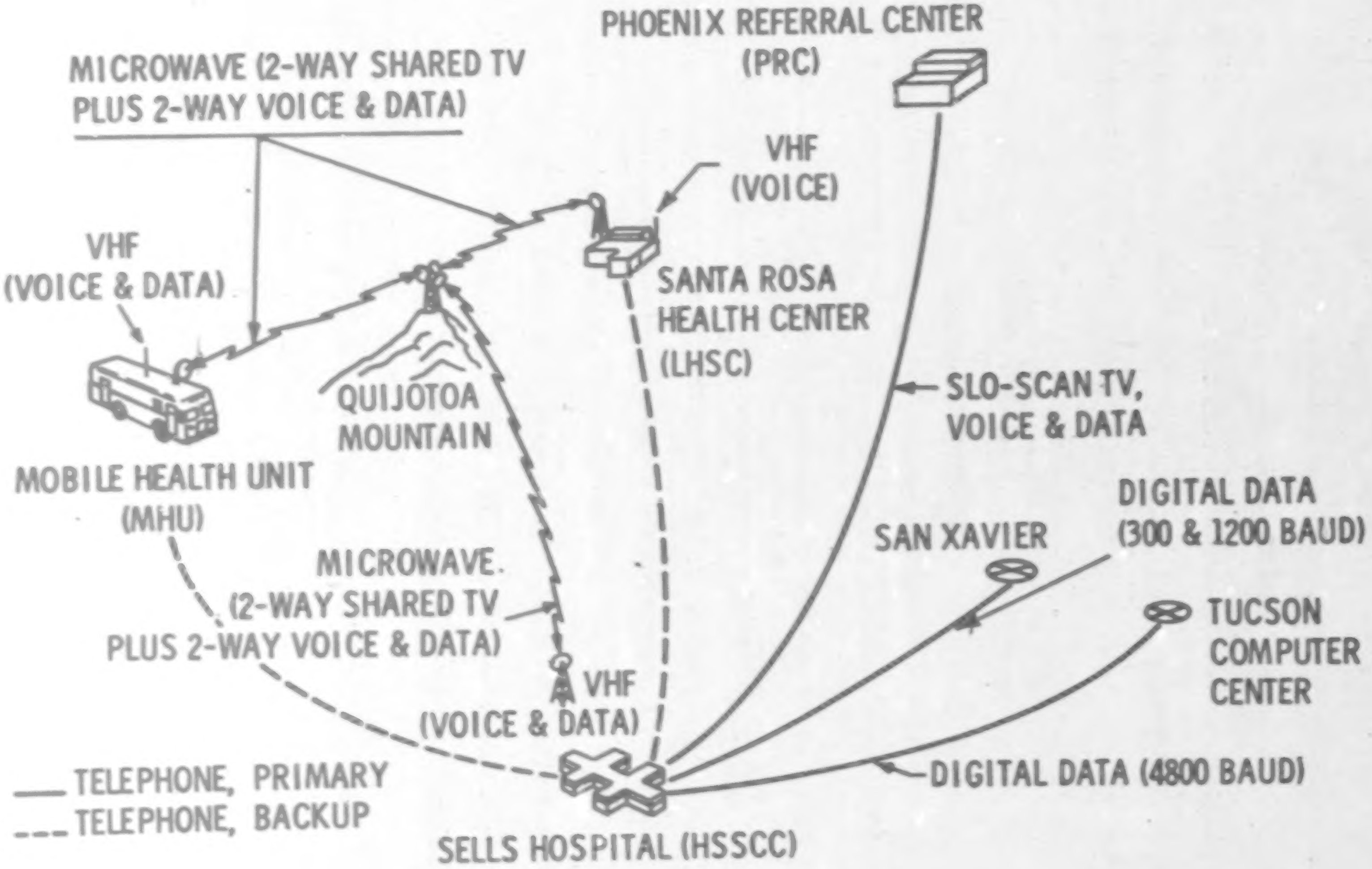
MICROWAVE (2-WAY SHARED TV PLUS 2-WAY VOICE & DATA)
PHOENIX REFERRAL CENTER (PRC)
VHF (VOICE)
VHF (VOICE & DATA)
SANTA ROSA HEALTH CENTER (LHSC)
QUIJOTOA MOUNTAIN
SLO-SCAN TV, VOICE & DATA
MOBILE HEALTH UNIT (MHU)
DIGITAL DATA (300 & 1200 BAUD)
SAN XAVIER
MICROWAVE (2-WAY SHARED TV PLUS 2-WAY VOICE & DATA)
TUCSON COMPUTER CENTER
VHF (VOICE & DATA)
TELEPHONE, PRIMARY
TELEPHONE, BACKUP
DIGITAL DATA (4800 BAUD)
SELLS HOSPITAL (HSSCC)

Figure 3. STARPAHC System Configuration. From Reference (140).

levels of education and training (e.g., the various types of physician's assistants), cost-effectiveness of the services, and continuing medical education for remote practitioners and consumers health education. (13) NASA's ATS-F satellite will provide the channel capacity for the transmission of the video signals in the Alaska Health Care Experiment. These channels will be used in conjunction with the audio communication channels of the ATS-1 satellite, which have been used previously to provide medical assistance to native health aides in the Tanana region of Alaska since 1971. (48, 146)

The Veterans Administration project will experiment with specialist consultations via NASA's ATS-F satellite and the broadcasting of training materials for paramedics for emergency medical services. The project's objective is to "test management, technical, cultural, and programming facets of remote interaction (clinical and cultural) prior to a large commitment to satellites as the method for achieving health care and educational requirements of the U.S." (13)

Several of the telemedicine systems plan to utilize computer terminals to keep various types of records on their patients. (See Table 12.) This should be an effective way to collect solid baseline data on the populations served, to be used to make comparisons over a period of time.

5.2 TRANSMISSION SYSTEMS

Technological advances in the communications field in recent years have made several alternatives available for telemedicine transmissions. The choices selected by the telemedicine systems planned or in operation have varied considerably. (See Tables 9 and 10.) This choice is dependent on several factors, including:

Table 9. Telemedicine: Communications Modes Required For Various Services. From Reference (89)

Requirement	Communications Mode
Input/output terminals for computer systems.	Narrowband-telephone grade circuits.
Voice (hot line to referral centers).	Narrowband-telephone grade circuits.
Physiological signals such as respiratory rates and volumes, electrocardiographic signals, and heart sounds.	Narrowband-telemetry with excellent low frequency response.
Photographs, charts, X-rays, non-real-time examination of subjects, prescription orders, hand or typewritten material, diagnostic/therapeutic sketches, strip chart tracings (EGG, PCG, etc.).	Narrowband-facsimile and/or slow scan TV.
Live (real-time) visual examinations of subjects in color, interactive, video educational material.	Wideband-video grade duplex TV transmission circuits.
Live (real-time) visual examination of subjects in black and white, interactive, video educational material. High resolution pictures.	Wideband-video grade duplex TV transmission circuits.

Table 10. Telemedicine Projects: Type of Transmission System

	Picturephone Lines	Cable	Standard Telephone Lines	Microwave (Terrestrial)	Microwave (Satellite)	Laser	Reference
MGH-Logan				x			(2)
MGH-Bedford				x			(2)
Lakeview		x					(4)
Harlem-Mt. Sinai		x					(5)
Bethany/Garfield	x	x					(7)
Case Western Res.						x	(8)
Illinois Mental H.	x						(152)
Cambridge Hospital (a)				x			(139)
Blue Hill, Me.				x			(11)
STARPAHC (b)				x	x		(12)
Alaska-ATS-F (b)				x	x		(13)
Veterans Admin. (b)				x	x		(13)
New Hampshire/Vt.				x			(14)
Nebraska Radiology			x				(15, 139)
Florida Penal Inst.		x	x				(16, 17)
CTS (b)				x	x		(18, 19)
Nebraska VA			x	x			(20)
Farmington, Me.				x			(21)
Ohio Valley				x			(22)
Puerto Rico (b)				x			(23)
Jacksonville				x			(143)
Cook County Hosp.	x						(24)
Arizona Network (b)			x	x			(25)
Boston City Hosp.			x				(26)

(a) Project terminated.

(b) Not yet operational.

(i) Type of terminal devices to be used in the system.
(ii) Distance between terminals.
(iii) Equipment already existing in the area and its operational reliability.
(iv) Availability of radio frequencies.
(v) Weather conditions and topology of the region.
(vi) Costs and resources available.

The technologies which are currently available for telemedicine systems include telephone lines, terrestrial or satellite microwave, laser, or direct cables. Each has certain attributes and weaknesses, generally a function of one or more of the above factors.

5.2.1 Telephone

Standard telephone lines are the most commonly available mode for telemedicine communications systems because one has random access telephone service to most parts of the United States from almost anywhere else. However, telephone service is not dependable in all rural areas. (48, 147) Telephone cables have a bandwidth of about 3 KHz, making them unsuitable for live two-way television transmission which requires "wide-band" (about 4.6 MHz per channel) capacity. (148) Telephone lines are sufficient for voice communication, facsimile devices, slow-scan television with the appropriate storage devices, and some computer input and output terminal devices. (See Table 9.) The suitability of slow-scan devices for particular tasks depends upon the rate at which information is required by the user, since the rate of information transmission is proportional to the bandwidth. (148)

Telephone lines and the appropriate terminal devices provide the capability for computer access, and the transmission of charts, X-rays, photographs, "non real-time" examination of patients, prescription orders, drawings, and strip-chart tracings of cardiograms. (89) An important objective of the Boston City Hospital Telemedicine Nursing Home Project is to determine whether a telephone is sufficient for the disposition of medical problems in situations in which the patients' cases are familiar to the doctor and frequently present chronic problems for treatment. (26) The results of the Nursing Home Telemedicine Project should help to more clearly define the limitations on the telephone for the delivery of health care from a remote location.

5.2.2 Picturephone

In terms of bandwidth, between the narrow-bandwidth standard telephone lines and the broad-band two-way television systems, is the Bell Picturephone, which uses a bandwidth of 1 MHz. Although it requires transmission lines different from standard telephone lines, predictions have been made that the Picturephone will be available in certain areas on a fairly large scale in the future, although this remains to be seen. (148, 149) If the Picturephone becomes available on a large scale and a large number of persons subscribe to Picturephone service in the future, a reduction of the present service rates might be expected, however the Picturephone might still be quite expensive. The Picturephone may not be of high enough resolution for many telemedicine services, including close-up examination of the body, laboratory test transmissions, and X-ray interpretations. (There is presently some disagreement in this area, which will be discussed in Chapters 5 and 6.) The

Picturephone appears to be sufficient for counseling purposes and specialist consultations, as well as the transmission of any images not requiring high resolution. A distinct advantage of the Picturephone over some other systems is its ease of operation, e.g., it does not require special lighting. However, at present its use is not widespread and its future development is not at all certain.

5.2.3 Cable

In recent years there has been a rapid growth of cable television systems, and predictions of the "wired city" of the future. (148, 150) This would appear to make cable television a prime choice for telemedicine because of its large-scale availability.

The large bandwidth and high quality of cable television systems makes it technically possible to provide two-way video transmission suitable for all contemporary telemedicine tasks. The development of cable television systems capable of two-way video transmission has been quite recent, and at least one telemedicine project has reported difficulty due to the newness of the technology, which was eventually corrected. (4) Another telemedicine project using a two-way video cable system is reported to have been down only about 1% of the total operating time due to problems with the cable system. (80) At the present time, even the best systems available are limited to about 10 miles between terminals, beyond which distance their performance is unacceptable, according to the report of one of the telemedicine projects. (25)

It may be possible to set aside some channels on a commercial system for telemedicine services, but significant problems arise in regard to privacy and the number of channels required.* Privacy can be made relatively secure by scrambling signals, but this adds to the costs. In regard to channel usage, the use of some channels on a commercial system for interactive television and others for unidirectional broadcasts may add an unfair economic burden to the regular commercial users. In response to this, the Health Committee of the Committee on Telecommunications of the National Academy of Engineering has recommended that the telemedicine systems install their own cables. (151) They believe that the commercial cable companies should be given appropriate incentives to install the telemedicine systems cables at the same time as their own and share underground ducts or pole space to reduce costs.

5.2.4 Microwave

Microwave radio ("wireless") systems are being used by at least half of the telemedicine projects. (See Table 10.) These systems use line-of-sight microwave relay towers spaced between 20-50 miles apart, depending on the terrain. (149) (The repeaters, i.e., amplifiers, are necessary to maintain the strength of the signals and to direct the line-of-sight signal to the next relay point.) The FCC assigns frequencies in the 6 GHz and 12 GHz bands for telemedicine microwave transmission. The wide-band capacity of microwave systems allows any of the terminal devices necessary for telemedicine to be used. However, there are certain legal restrictions which may make microwave systems less desirable than the others, including the requirement of licenses for transmission on these bands. The New Hampshire-Vermont Interactive Medical Network reports that their license for the 12 GHz band (which is easier to get licensed for than the 6 GHz band) requires that more than 50% of the use must be for educational purposes. This would impose serious constraints on a system designed primarily for telemedicine patient services. (14)

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*Most commercial cable television systems are designed for one-way television or one-way television with voice or digital return.

Communication satellite links can offer a broader geographic range than terrestrial microwave systems. In some areas, high frequency radio is plagued by ionospheric disturbances and interference by mountains, causing "blackouts" for long periods of time, making satellites a better choice than terrestrial systems. (48) Advanced design satellites, which broadcast in the 12-14 GHz range (e.g., The Communication Technology Satellite, "CTS"), are capable of transmitting to a variety of locations, including urban areas, without the problem of stray signal interference experienced by other systems. (153)* Perhaps the most significant feature of satellites is their ability to transmit all telemedicine communications signals as a link between any of the other types of local systems, enabling the signals to reach remote areas.

5.2.5 Laser

There are certain problems inherent in microwave links and cable systems which are not found in laser communication systems, in an operating range up to several miles. Cable systems require a large initial investment and are characterized by numerous installation problems. Natural obstacles in the terrain, dense urban environments, and difficulty involved with securing the right-of-way access make microwave and laser systems more advantageous. Microwave systems require a license (assuming that frequencies are even available), and cable systems are regulated by a variety of local and FCC ordinances. Presently, optical communication links (e.g., laser) are not subject to government licensing, but probably will be subject to safety regulation in the form of a type of certification in the future. Laser systems also offer the best guarantee of protection from outside monitoring. Privacy is guaranteed on microwave and cable systems only with sophisticated message scrambling, and cables can be tapped in a variety of ways. Laser signals require more sophistication for unauthorized monitoring, and clumsy attempts can be more easily detected. Cable and microwave systems are also affected by switching of heavy machinery and poorly regulated power supplies in heavy industrial environments. If the receiver and transmitter themselves can be shielded adequately in laser systems degradation of signals can be avoided. However, there is one serious problem with laser systems. They can be affected by inclement weather, but over short ranges the benefits generally outweigh this slight loss of quality. It should be noted that cable systems, if properly installed, are generally immune from environmental effects, unless they reach extremes (e.g., earthquakes or hurricanes.) (8)

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*Satellite transmission at 12 GHz must take into account factors such as rain attenuation in that band.

5.2.6 Choice of Transmission System Technology

Some of the telemedicine projects have run into the problems outlined above. For example, the Arizona Telemedicine Network (in planning stages) has chosen to use a microwave system because its planners believe that the expense of long-haul cables is too great over the long distances they hope to link, and the right-of-way access is a problem.

They have also eliminated CATV technology from their considerations because of its unacceptable performance when the cascade gets much beyond 30 amplifiers in line, or about 10 miles of cable run. They have also stressed their desire for using "off-the-shelf" equipment for their systems, due to the likelihood that such equipment has been tested and proven and is ready for delivery at a reasonable cost. (25)

The Lakeview Clinic project chose to use cable for their project because they felt that a cable system provided a higher degree of reliability and because it was not as susceptible to environmental conditions as other types of systems. The cost of cable and microwave would have been about the same for their system, but the coaxial cable system offered more channels, which they hope to use in the future for other social services in the area. The coaxial cable system also offered them the capability for three-point multiconferencing, a feature that point-to-point microwave systems did not offer. (4)

5.3 EQUIPMENT IN USE FOR TELEMEDICINE

The present experimental state of telemedicine is clearly manifest in the broad range of types of equipment in use. The type of equipment and personnel selected is a function of the physician's assistant's training (both in medicine and equipment operation), the distance between the remote clinic and a more sophisticated facility and/or physicians and specialists, and state regulations and local interpretation of them. Table 11 shows the variation of sophistication of physiological monitoring equipment, with a pattern generally indicating the use of more sophisticated equipment at the more isolated locations. The obvious exceptions are projects such as the Massachusetts General Hospital-

Table 11. Telemedicine Projects: Remote Diagnostic Equipment

	EKG (a)	Stethoscope	X-Rays	Laboratory Test	Blood Pressure	EEG (b)	Ultra Sound	Fibre Optics (c)	Reference
MGH-Logan	x	x		x	x				(2, 3)
MGH-Bedford	x	x	x	x	x				(2, 3)
Lakeview		x							(4)
Harlem-Mt. Sinai		x							(80)
Bethany/Garfield				x					(6)
Case Western Res.	x	x			x				(8)
Illinois Mental H. (g)									
Cambridge Hospital (d)									
Blue Hill, Me. (f)									
STARPAHC (e)	x	x	x	x	x				(11)
Alaska-ATS-F (e) (f)									
Veterans Admin. (e) (f)									
New Hampshire/Vt.	x	x							(14)
Nebraska Radiology			x						(15)
Florida Penal Inst.	x	x							(16, 17)
CTS (e)	x		x		x		x	x	(18, 19)
Nebraska, VA						x			(20)
Farmington, Me.	x			x	x				(21)
Ohio Valley (f)									
Puerto Rico (e)	x	x	x	x	x	x			(23)
Jacksonville		x							(143)
Cook County Hosp.			x						(24)
Arizona Network (e)	x	x	x	x	x				(25)
Boston City Hosp.	x								(26)

(a) EKG is the abbreviation for electrocardiagram.

(b) EEG is the abbreviation for electroencephalogram.

(c) Fibre optic devices are used for the examination of body orifices.

(d) Project terminated. (e) Not yet operational. (f) Information not available.

(g) Not applicable.

Logan Airport and Bedford VA Hospital links, which are heavily involved in evaluating many different devices and applications of telemedicine. Their findings will serve as models for remote clinics.

The equipment presently used in telemedicine systems can be classified into three general groups, based on use:

(i) Direct transmission of physiological data.

(ii) Printed or written administrative information and patient records.

(iii) Audio-visual communication for all purposes.

5.3.1 Direct Transmission of Physiological Data

The devices necessary for the direct transmission of physiological data include those necessary for remote monitoring of electrocardiograms, blood pressure, cardiac auscultation, outlining of internal masses and viewing into body orifices (i.e., ear, nose, throat, rectum, etc.). (See Table 11.) For remote clinics located within a reasonable distance of a more sophisticated facility it may be necessary to provide the capability for the direct transmission of only the vital indicators of the patient's condition, e.g., EKG, pulse, respiration. Devices such as the ultrasound transmitters and fibre optic devices for probing the body orifices add additional expense and may be unnecessary and unused in many situations. The Lakeview Clinic's telemedicine project found that the electronic stethoscope was not needed extensively in their scheme of health care delivery, which did not include having a physician's assistant at a remote location. (See Section 5.1.) In a survey of doctors involved in the project, an interest in a more perfect stethoscope was shown, as well as a desire for several other physiological transmitting devices. (4) The Communication Technology Satellite Telemedicine project plans to test fibre optic devices and ultrasound because their scheme will include interaction between extremely remote locations which possess little accessibility to sophisticated central medical facilities. (18)

5.3.2 Printed or Written Information

Printed and written administrative information includes prescription orders, electrocardiograms, X-rays, patient records, lab results, images of skin lesions, in-hospital forms and medical illustrations. The devices used to transmit these are slow-scan television, narrow-band facsimile devices, and direct telewriters. If high resolution is not required any of these devices can be used. However, the standard "business fax" facsimile devices are apparently not sufficient for X-ray transmission, and slow-scan systems must be used. Some of the slow-scan video systems allow you to store the image on a magnetic storage disc, for either local playback or conversion for slow-scan transmission. (17) The storage capacity for the "first generation" system is five images; however, shortly systems capable of storing up to 200 images will be available. (154)

Several of the telemedicine systems are using, or plan to use, devices to transmit printed or written information. For example, the Massachusetts General Hospital-Logan Airport system uses a tele-writer for prescription-writing and transmission of doctor's orders to the Airport Medical Station. (3) The study of physician's needs conducted at the Lakeview Clinic revealed an interest in obtaining hard-copy facsimile equipment for the reproduction of patient charts, electrocardiograms, and X-rays. (4) The Boston City Hospital Telemedicine Nursing Project utilizes a facsimile device to transmit EKG tracings, prescriptions, doctors' orders and nurses' notes. (26)

5.3.3 Audio-Visual Information

The transmission of audio-visual information requires the most sophisticated equipment. The audio-visual terminal devices include cameras, microphones, and television monitors. (See Figure 4.) One of the major considerations in selecting the camera is the quality of resolution desired, which is based upon the particular use of the system. Some early experiences with telemedicine have indicated that the Bell Picturephone may not be sufficient for satisfactory quality X-ray transmissions. (6, 83) By contrast, the Cook County Department of Urology doctors report that they are able to perform satisfactory interpretations of radiological data with enhancement of image in some cases, due to the control of brightness on the Picturephone. (24) Those reporting poor X-ray interpretation quality attribute it to poor resolution of the image in the Picturephone.

The Lakeview Clinic has used a camera with 525 lines because they hoped to be able to use the standard television monitors in patients' rooms for transmissions. However, their report indicated that this may not have been a high enough resolution for certain tasks. (4) The Massachusetts General Hospital systems use cameras with 800 lines horizontal resolution, and find it to be sufficient for all of the uses they have attempted. (155) Both the Case Western Reserve University Project (8) and the Lakeview Clinic Project (4) reports expressed the belief

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Figure 4. Features of a Telediagnosis System. From Reference (155).

that a 1,000 line camera would be good for reading charts and printed material, although it would be quite expensive. Another problem arising in X-ray transmission is the use of color camera signals. Apparently the resolution of many color television systems is not of sufficient quality for the required details. One project plans to use filters in their system to permit operations in the monochrome mode to eliminate this problem. (25) Some radiologists have complained that no system offers a sufficient quality image for X-ray interpretation. Dr. Kenneth T. Bird of Massachusetts General Hospital explains that they might not be using the proper zoom and focus camera capability. (83) Their failure to use these adjustments would not allow them sufficient manipulation of the image to properly identify the X-ray image.

For laboratory test transmissions, the Massachusetts General Hospital-Logan Airport link uses a camera connected directly to a binocular microscope. Four objective lenses of 40x, 100x, 450x, and 1000x magnification are available. (See Figure 5.) (The doctor and nurse are able to view the lab speciment simultaneously through the binocular microscope.) (155)

The use of special lenses and focus capabilities are important for general diagnostic purposes also. A wide angle lens can be helpful in examining a patient on television because it gives a depth of field which allows the patient great range of movement. The wide angle lens also allows an undistorted view of the patient's face and upper body, even in a small room. The wide angle lens permits the doctor to get close-up views of skin lesions by a focus adjustment and presentation of the lesion close to the camera. (4) Telephoto lenses can be of

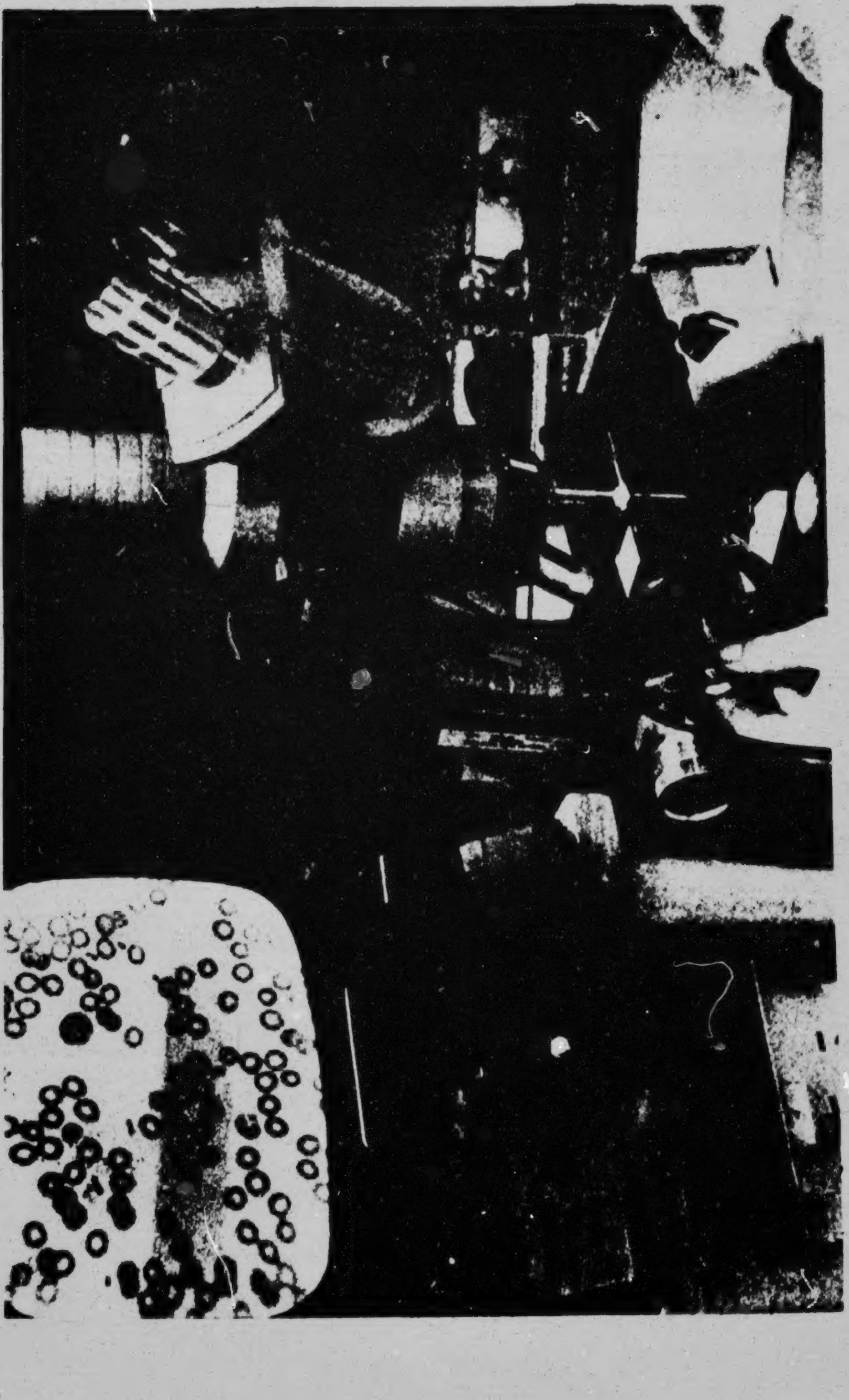

Figure 5. The Microscope-Television. From Reference (3).

value for certain purposes; however, there has been some hesitation to use them because not enough of the patient's body is visible to receive all nonverbal cues. (4) Most of the systems use a remote-controlled zoom lens to allow manipulation of the image. The Massachusetts General Hospital Telecenter uses a 10:1 ratio lens, with apparent satisfaction. (156) Other projects have tried a 4:1 ratio zoom lens and found it to be insufficient, believing that a 15:1 ratio would be considerably better. (4)

Great attention has been given to the placement of the cameras and monitors and the image size in the telemedicine systems. Primarily, concern has been with the maintenance of eye-contact and the maintenance of normal images. The Massachusetts General Hospital Telecenter reports that they initially had the monitor in the Logan Airport Medical Station examination room mounted at a height which allowed eye-level contact between the doctor on the monitor and the patient on the examination table. After some experience with the system, they realized that the monitor should have vertical mobility to allow adjustments for the patient's position. They became especially aware of this problem when they used the system for interprofessional discussions, during which participants misinterpreted the height of the television monitor as an assertion of dominance. (83) Although the eye-contact level is presently lined up, other problems may still cause uneasiness in regard to eye-contact. (See Section 7.4.)

An early experience of some telemedicine experimenters revealed the importance of maintaining a normal head and shoulder image size. A zoom lens at the child health clinic of the East Harlem Broadband

Communications Network was adjusted for a distance of 75 mm, resulting in the nurse's image covering 1/4 of the monitor, while the lens at the medical center (25 mm) provided an image of the doctor encompassing most of the screen. Once the staff became aware of this discrepancy in image size, they learned to adjust the zoom lens to provide approximately equal images. However, despite these efforts, one of the nurses expressed the feeling that the doctor appeared to be a mighty authoritarian figure, dispensing expertise, that invoked an image of "The Face of God." (5) There is an additional problem posed by multiple-person use of the systems, as even the largest standard television monitor available (i.e., 23") is not large enough to comfortably fit a pair of head and shoulders of normal size on the screen. (83) Using a Picturephone, you are limited to even smaller images by a 5" by 5.5" screen. (148)

In striving for the most efficient and comfortable relationship between interactants in telemedicine, experimenters have compared black and white transmissions to color transmissions. Preliminary observations indicate that color images, which cost more to produce and require frequent adjustments to maintain quality, may only be warranted for certain telemedicine tasks. Both Murphy, et al. (158) of Massachusetts General Hospital and Seibert, et al. (14) of Dartmouth University have independently studied the role of color television in dermatological diagnosis. Murphy, et al. have observed that color television offers a slightly higher level of diagnostic accuracy, and are joined by Seibert, et al. in the conclusion that color television affords a more rapid diagnosis. The latter conclusion makes color more acceptable to dermatologists. In response to this, Bird, et al. have expressed an interest in introducing a color camera to the Massachusetts General Hospital system to reduce the dermatologist's reliance on the physician's assistant for description of colors. (3) Gravenstein, et al., in their study of an anesthesiologist's supervision of a nurse anesthetist, have concluded that color is probably essential for their purposes. (8) The doctors of the Lakeview Clinic have expressed the belief that a color image would be desirable for their telemedicine system, but that they would want to actually install a color system only if variations in color could be controlled and if costs would not be unreasonable. (4) (See Section 7.5 and Table 12.)

Efforts have been made in some projects to remove the "studio-like" feeling that might tend to make the patients feel uncomfortable. However, it is generally felt that it is desirable to have a particular location in the facility specifically designated for telemedicine. This would allow the equipment to be set up on a permanent basis and allow lighting to be adjusted optimally. Some projects have reported difficulty in their attempts to "de-studioize" the telemedicine location, due to technical problems. The New Hampshire-Vermont Medical Interactive Television Network's dermatology experimenters found that they required 100 foot-candles of light for optimum equipment function. This level is 2-3 times the lighting level in a well-lighted classroom, and apparently this intensity of light (and heat) caused some discomfort to the patients. (14) Another problem with lighting, unique to the hospital environment, has been reported by the Lakeview Clinic. They have found that, in some instances, picture quality is poor due to unavoidable backlighting, causing shadows on the image. This backlighting is caused by the lights over patients' beds and the predominance of white

Table 12. Telemedicine Projects: Communications Equipment At Remote Location

	Color Camera	Black and White Camera	Remote Control Camera	Special Telemedicine Studio	Computer Terminal	Reference
MGH-Logan		x	x			(2, 3)
MGH-Bedford		x	x			(2, 3)
Lakeview		x	x			(4)
Harlem-Mt. Sinai		x	x			(5, 28)
Bethany/Garfield		x			x	(6)
Case Western Res.	x	x	x			(8)
Illinois Mental H.		x				(152)
Cambridge Hospital (a)		x	x			(157)
Blue Hill, Me.		x	x			(1)
STARPAHC (b)	x	x	x	x(c)	x	(12, 140)
Alaska-ATS-F (b) (d)						
Veterans Admin. (b) (d)						
New Hampshire/Vt.	x			x		(14)
Nebraska Radiology		x(e)				(15, 159)
Florida Penal Inst.	x	x	x		x	(16, 17)
CTS (b) (d)						
Nebraska VA		x				(20)
Farmington, Me.		x				(21)
Ohio Valley	x					(22)
Puerto Rico (b)		x	x			(23)
Jacksonville		x	x			(143)
Cook County Hosp.		x	x			(24)
Arizona Network (b)		x	x		x	(25)
Boston City Hosp.		x(e)				(26)

(a) Project terminated. (b) Not yet operational.

(c) Fixed location in mobile van. (d) Information not available.

(e) Slow-scan or facsimile device.

backgrounds in hospitals. To counter this effect, they have used a front light and black backdrop when transmitting from a hospital room site. (4)

Not much attention has been given to the manipulation of sound. Some projects have stressed the importance of discrete placement of microphones (156, 159), while others use lavalier microphones (14). Apparently, there has been little or no patient feedback on deficiencies in the sound systems in use.

5.4 SOME FACTORS IN EQUIPMENT SELECTION AND DESIGN

Several factors are of great importance in the design and selection of equipment for telemedicine. These include:

(i) Ease in operation.
(ii) Unobtrusive hardware.
(iii) Field-tested reliability.
(iv) "Off-the-shelf" availability (for standard communication equipment).
(v) Modular units.

Ease in operation is the most frequent feature requested by the medical personnel operating the equipment. (4, 5, 25, 80, 159) This includes features such as maximum control with a minimal number of control dials, rapid initiation of the system when it is switched on, and easy switching from one mode to another. The ability to remotely control the camera at the other location has been stressed as being extremely important. (3, 4, 8, 80) This feature is necessary to permit the person at the controls to see exactly what he wants to see, not what another person chooses to focus the camera on, and to allow the person at the other terminal to perform the medical tasks without having to adjust the equipment. The report of The Lakeview Clinic states that a "joy stick" would be the ideal control for the remote pan, tilt, and focus of the camera. (4) The Massachusetts General Hospital employs such a device to facilitate control. (See Figure 6.)

Gravenstein, et al. believe that the pan, zoom, and tilt actions must be rapid and quiet for the most efficient use in the operating room. They have also found that open microphones and loudspeakers might be beneficial, especially for the nurse anesthetists in emergency situations, when the headset or microphone might otherwise be in the way. (8) In keeping with the objective of simple-to-operate equipment, the telemedicine projects have been careful to select cameras which require a minimal amount of adjustment. For example, The Massachusetts General Hospital Telecenter has selected the Norelco Plumbicon camera, which permits relatively adjustment-free operation. (159)

The desirability of unobtrusive hardware is based upon the goal of some telemedicine systems discussed above to keep the transmission rooms free from a studio-like appearance. The technical equipment must often remain in plain sight, but it can be neatly constructed and compacted so it won't be so obvious to the patient. The Massachusetts General Hospital Telecenter has the doctor's controls and video monitor built right into his desk, and the physical monitoring devices are located to his side, all out of view of the patient, but easily available to the doctor. (159) (See Figure 7.) By contrast, the Lakeview Clinic has used specially designed videocarts which are mobile self-contained transmitting and receiving stations. On these videocarts the equipment is in plain sight of the doctor and patient. (4)

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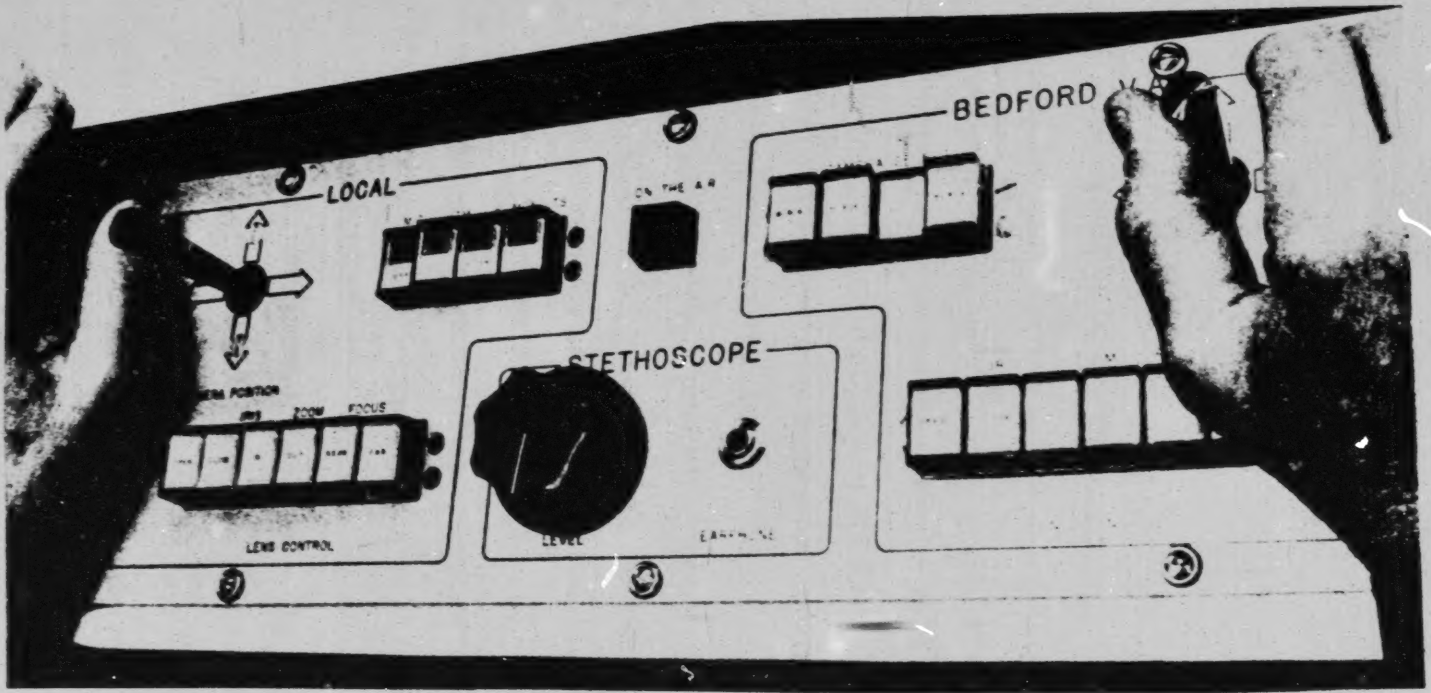
LOCAL
BEDFORD
ON THE AIR
STETHOSCOPE
ERA POSITION
IRIS
ZOOM
FOCUS
LENS CONTROL
LEVEL

Figure 6. The Massachusetts General Hospital Control Panel. From Reference (3).

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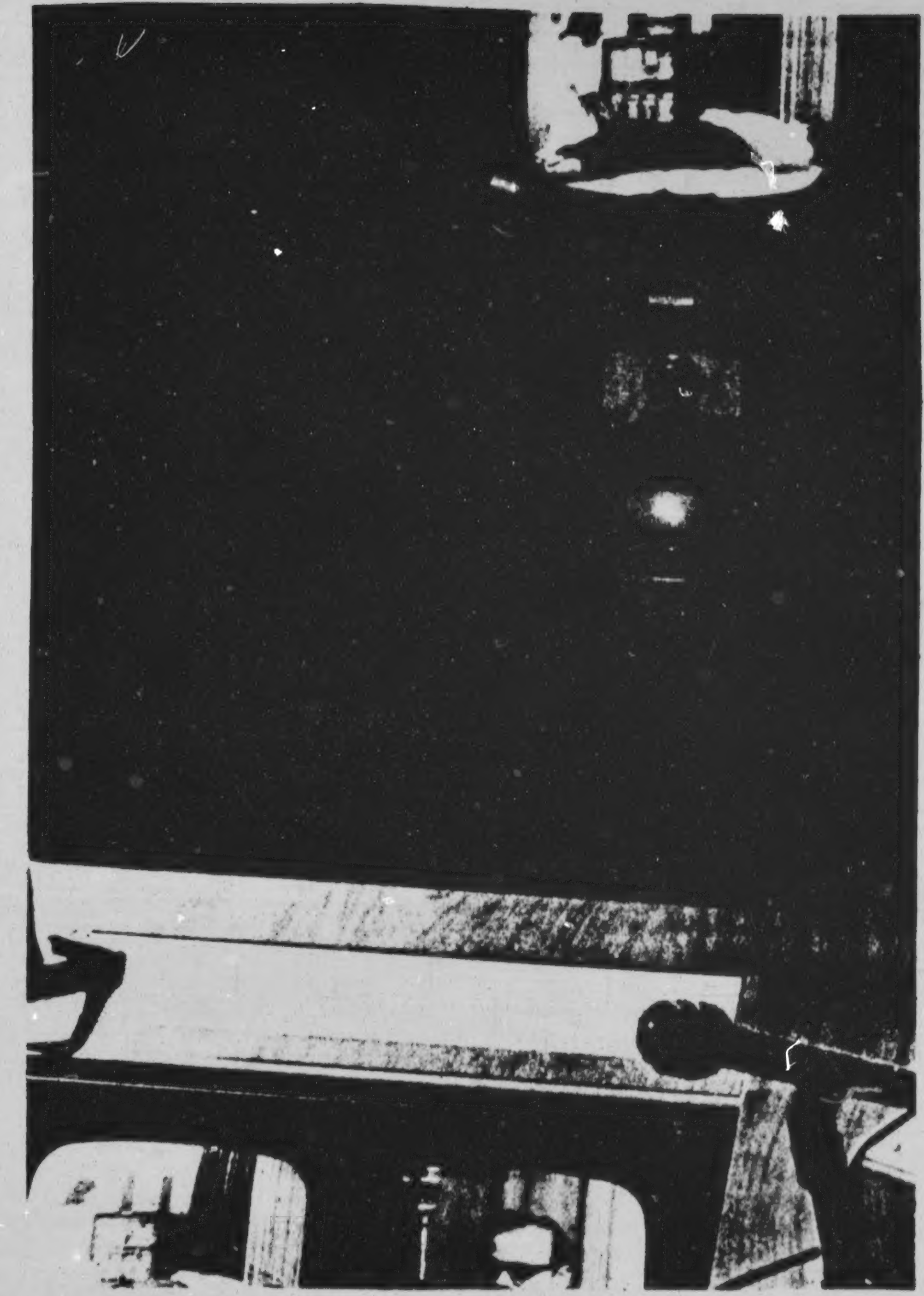


Figure 7. The Massachusetts General Hospital Control Console. From Reference (3).

In the planning and construction of new telemedicine systems some difficulty has been encountered with equipment, because some devices haven't been previously used for this type of application. At least two of the telemedicine projects have found that the electronic stethoscopes did not initially work up to expectations (4, 8), and required some time to get them operating properly. A significantly more serious problem was encountered by the Lakeview Clinic's interactive cable television system, which was subject to technical failure due partially to the lack of sufficient field-testing prior to installation. During the first eight months of the project, the system did not perform reliably or with the quality desired for all telemedicine applications. The major faults of the system were in the form of excessive cross-modulation and lack of flatness of response due to the design of the reverse amplifier. This problem has not arisen in other bi-directional cable systems because they have used only one reverse television channel, whereas the Lakeview Clinic system uses three reverse television channels. The Lakeview Clinic's project report sums the problem as follows:

> "However, no provision has been made for allowing technical improvements and modifications to upgrade the performance and utility of the system to accommodate the needs identified by the health care providers. As problems arise and solutions are found they should be implemented into the system. It is strongly recommended that a system should first be perfected and accepted as a usable instrument before its utilization in a health care system is evaluated." (4)

New amplifiers were eventually installed in the cable system and the problems were reported to have been eliminated. (4)

Most of the telemedicine systems report rather high equipment reliability. For example, the Massachusetts General Hospital-Bedford VA link is reported to have been down only .8% of the total operational time. Of the total 14 system failures, 8 were at the microwave repeater site, 2 of which were due to lightning strikes, a situation not amenable to prevention except by means of a stand-by second identical circuit, which is not economically feasible for the Massachusetts General Hospital-Bedford VA link at the present time. (27)

The Mt. Sinai project is reported to have been down about 55 hours of the total 900 hours of operating time, roughly 6% of the time. The 55 hours of down-time breaks down to 25 hours due to electrical supply, 10 hours due to the cable system, and 20 hours due to the television equipment. (80)

In general, the maintenance of medical equipment has not always been consistent with the dependence placed upon it by health care providers and patients. As telemedicine systems are introduced into new areas, people will begin to depend upon them as the link between the physician's assistant and medical expertise. As this dependence grows, the need for minimum standards, more field testing, and backup systems becomes more critical.

If the maintenance of telemedicine systems follows the pattern of other health care equipment, there may be little reason to believe that its operating quality will be maintained. According to Bruner, in The National Academy of Sciences Symposium on Electrical Hazards in Hospitals:

> "After occupancy, the observation that preventative maintenance seems to be practically unknown in medical institutions is the natural result of starting with inadequate personnel and making no attempt to educate them." (160)

This has not been a problem with the telemedicine systems in operation to the present time. However, they are in the experimental stages and may be receiving more attention that when operational on a routine basis.

5.5 THE ROLE OF INDUSTRY IN TELEMEDICINE

In some respects the increased availability of medical technologies has made health care institutions more vulnerable to the "medical-industrial complex". (161) Ribicoff (162), Krause (163), and others point out that health care institutions frequently will not deny requests for equipment by their medical staffs, regardless of real need. This has been a contributing factor to the soaring costs of medical care (163, 164, 165) and the accumulation of some fairly useless and/or unneeded equipment. (166, 167)

If this pattern is extended to telemedicine, one might expect the electronics industry to become quite involved in the development of this potentially profitable area. In actuality, cable television and electronics companies have already shown great interest in the development of telemedicine. The cable television company working with the Lakeview Clinic looks forward to an expanded system including "e.g., the school systems and business and municipal services". (4) Westinghouse Health Systems (16), Lockheed Aircraft (12), Hughes Aircraft (168), and Bell Telephone Company (7) are presently involved with the development of telemedicine to some degree. (See Section 10.3.) In a related area we see the pharmaceutical companies advertising on medical education television channels (30), a practice that is not likely to occur on point-to-point telemedicine systems as they now exist, but which could become possible in the future as telemedicine networks grow.

The issue of private industry's involvement in telemedicine is difficult to resolve. The private companies are in a position to provide the resources needed for the development of high quality systems. In addition to their profit orientation, it is conceivable that they might have a sincere interest in the improvement of health care. It would be contrary to American political and economic policy to limit their involvement outright. However, it would be acceptable to scrutinize their activity in the area, to be sure that their actions do not bias the evaluation of the technology or inhibit experimentation with other approaches to health care problems.

5.6 COSTS OF TELEMEDICINE

Since telemedicine is in the early stages of development, it is difficult to assess what the costs will be in the future as its use becomes more widespread. The costs for implementing a telemedicine system will be a function of the following factors:

(i) Equipment required for the specific application of the project.
(ii) The number of locations linked by the system.
(iii) Cost of purchasing and installing equipment.
(iv) Cost of special staff training.
(v) Equipment operating costs and personnel salaries.
(vi) Rental costs for equipment space.
(vii) Additional malpractice insurance premiums.

The equipment required for specific types of health services varies considerably. (See Sections 5.2 and 5.3.) For most medical applications it is not known exactly what level of equipment sophistication is required. Some telemedicine projects have used, or plan to use, devices such as direct electrocardiographs, electroencephalographs, electronic stethoscopes, fibre optic examining instruments, and color television cameras, while others have found a bi-directional black and white television system to be sufficient for their purposes. (See Section 5.3.) Others have found that the expense of wide-band transmission systems may not be necessary.

The Boston City Hospital Telemedicine Nursing Home project has found that a telephone and facsimile device may be sufficient for communication between a physician and a nurse practitioner for the care of nursing home patients whose cases are already known to the physician. (26) The Cambridge Hospital telemedicine project nurses and doctors have expressed the belief that the telephone may be sufficient for most of the types of cases that they handled over television. They found that television consultations required more time than telephone consultations and didn't necessarily provide more medical information. However, the television consultations appeared to reinforce the patients', physician's assistants', and physicians' confidence in the quality of care delivered. Although the overall number of clinic patients referred for in-person follow-up visits with a physician was not significantly different for patients initially seen by television or telephone, the sites of the follow-up consultations were significantly different. The telephone consultations more often than the television consultations required the patient to travel immediately to the hospital for a visit with a physician, rather than permitting an appointment to be made with the physician at the local health clinic at a later date. (157)

This has important implications for the use of telemedicine in the future. When physicians visit an inaccessible site only at periodic intervals, or when transportation is infrequent, the ability to delay with confidence the immediate need for the patient to see the physician may substantially decrease the proportion of referrals to a central facility. (157) If the care available at the remote clinic is of a high quality and the physician's confidence in delaying the in-person follow-up is proven to be justified this would be quite beneficial.

Difficulty has been encountered in the collection of cost information for the telemedicine projects. Table 13 includes information primarily on grants for telemedicine projects in addition to some information on installation and operating costs. It should not be inferred that the figures presented in Table 13 represent only the costs of constructing the actual telemedicine system.

The expense of equipment purchase and installation for Case Western Reserve University's two-way black and white laser telemedicine system is reported to have been about $50,000. (8) Ms. Rosemary Bonanno of the Cambridge Hospital telemedicine project has estimated that a system linking two locations with a two-way black and white microwave system should cost about $30,000. (157) Mr. Edward Wallerstein of the Mt. Sinai School of Medicine telemedicine project has estimated that a black and white bi-directional cable television system similar to the Mt. Sinai system should cost in the range of $100,000. (134) Dr. Kenneth Bird of the Massachusetts General Hospital has estimated that it would cost about $75,000 to create two telemedicine centers at a site from 20 to 40 miles apart. (170) These estimates include only the expenses for system construction and do not include other factors such as staff training and salaries, additional malpractice insurance premiums, and operating expenses which may vary widely and are generally reflected in the size of the project grant. The Case Western University telemedicine

Table 13. Telemedicine Projects: Costs and Funding (a)

	Initial Grants	System operating costs/hour	Installation Costs	Maintenance Cost/yer	Transmission System costs per year	Malpractice Insurance Premium/Yr.	Evaluation Costs	Reference
MGH-Logan (b)								(30)
MGH-Bedford	340,000							(139)
Lakeview (f)	195,000							(139)
Harlem-Mt. Sinai (f)	242,000							(139)
Bethany/Garfield (f)	187,000							(139)
Case Western Res. (f)	94,000		50,000	6,000		4,000		(8, 139)
Illinois Mental H. (f)	72,000							(139)
Cambridge Hospital (c) (f)	176,000							(139)
Blue Hill, Me.	79,000						9,000	(1)
STARPAHC (d)	3,350,000							(169)
Alaska-ATS-F (b) (d)								
Veterans Admin. (b) (d)								
New Hampshire/Vt. (b, f)		30						(14)
Nebraska Radiology (f)	128,000							(139)
Florida Penal Inst.	906,300							(17)
CTS (b) (d)								
Nebraska VA					51,000			(20)
Farmington, Me.			235,000					(21)
Ohio Valley	1,000,000							(22)
Puerto Rico (b) (d)								
Jacksonville (b)								
Cook County Hosp. (b)								
Arizona Network (b) (d)								
Boston City Hosp. (b)								

(a) All figures rounded to nearest whole dollar. (b) Information not available.

(c) Project terminated. (d) Not yet operational.

(e) Information on subsequent grants is not available in the available reports.

(f) See Appendix 12.1 for further information regarding grant.

project expects yearly operating expenses to approximate $6,000, with an additional $4,000 insurance premium. (8)

The great discrepancy in the estimates of system costs may be due at least partially to variations in equipment selection, but quite likely reflects some of the expenses of experimentation and design. For example, the planners of one telemedicine system have estimated that almost half of their projected development costs for the first system will be for the system software. (171)

It appears likely that the costs of constructing telemedicine systems will decrease as the number of satellite clinics is increased. (134) This may be attributed to the use of modular units, decreased costs for field-testing equipment, greater availability of cable and satellite transmission channels, and the increased size of future telemedicine networks.

There has recently been some discussion of performing cost-effectiveness studies of the telemedicine scheme for primary health care. The Cambridge Hospital telemedicine project staff has developed a computer model to compare the costs of a physician in solo practice to a physician's assistant at a remote clinic connected to a physician at a central medical facility by a telemedicine system. Their model indicates that the scheme involving the physician's assistant is approximately 20% less cost-effective in delivering health care to a defined number of persons than a physician in solo practice, due at least partially to the slower rate at which the physician's assistant works. The model is based on an arrangement in which a single physician supervises about 10 remote clinics, and it is projected that the scheme involving the physician's assistant would be less cost-effective if the number of clinics supervised by a single physician was decreased. Presently the limit on the number of remote clinics which can be effectively supervised by a single physician has not been determined. (10)

Other telemedicine projects have found that telemedicine can directly reduce costs by eliminating the need for the patient to travel to the central medical facility. The Mt. Sinai School of Medicine has found that a patient can be seen at the neighborhood clinic by a nurse practitioner with telemedicine physician backup for $30.00 as compared to the $50.00 cost for seeing a patient at the hospital clinic. This does not include the patient's savings in travel time and travel expense, both of which can be considerable in urban and rural settings.

The cost of implementing telemedicine systems and quite possibly the expenses incurred in the operational stage will have to be subsidized by outside parties, government or private, because many of the telemedicine systems will serve areas with indigent populations. Whether sources for funding can be found or not after the initial project grants terminate is likely to be a rather serious issue in the future of telemedicine. As in the case of other social services, telemedicine may be socially desirable, although not a profitable investment in terms of the rate of return on the invested capital for society at large. Cost-benefit analyses may help to develop some insight in this area, but, as in the case of other social services for the handicapped, poor, and rural populations, moral and social judgments may ultimately take precedence over the results of the cost-benefit analyses.

Cost-effectiveness studies may be quite beneficial in the determination of the most optimal approach to meeting the health care needs of populations in doctor-shortage areas. In addition to comparing the effectiveness of competing approaches, e.g., improved transportation systems for physicians and patients, studies may be quite helpful in the comparison of the different telemedicine technologies and the various combinations of manpower levels and technology. These include the range of technologies from narrow-bandwidth to wide-bandwidth, color to black and white, and the utilization of the various types of physician's assistants with diversified educational backgrounds. The results of these studies are likely to vary in different geographic areas.

The financing and implementation of telemedicine systems and remote clinics in many areas raises some very basic issues in regard to the assignment of monetary values to human life, and the underlying societal values which determine these. Since the local health clinic connected to the central medical facility by telecommunications may represent the only local health care outlet in some areas, perhaps the cost comparisons can be made only with the absence of all health care services and the consequent conditions.

6. EVALUATIONS OF TELEMEDICINE

Although medical care involves more than a series of "technical procedures", the success of these procedures are in a sense the prerequisites for overall quality care. If the specific procedures cannot be carried out, the doctor starts off with a considerable handicap, and can probably only expect to be moderately successful in treating his patient.

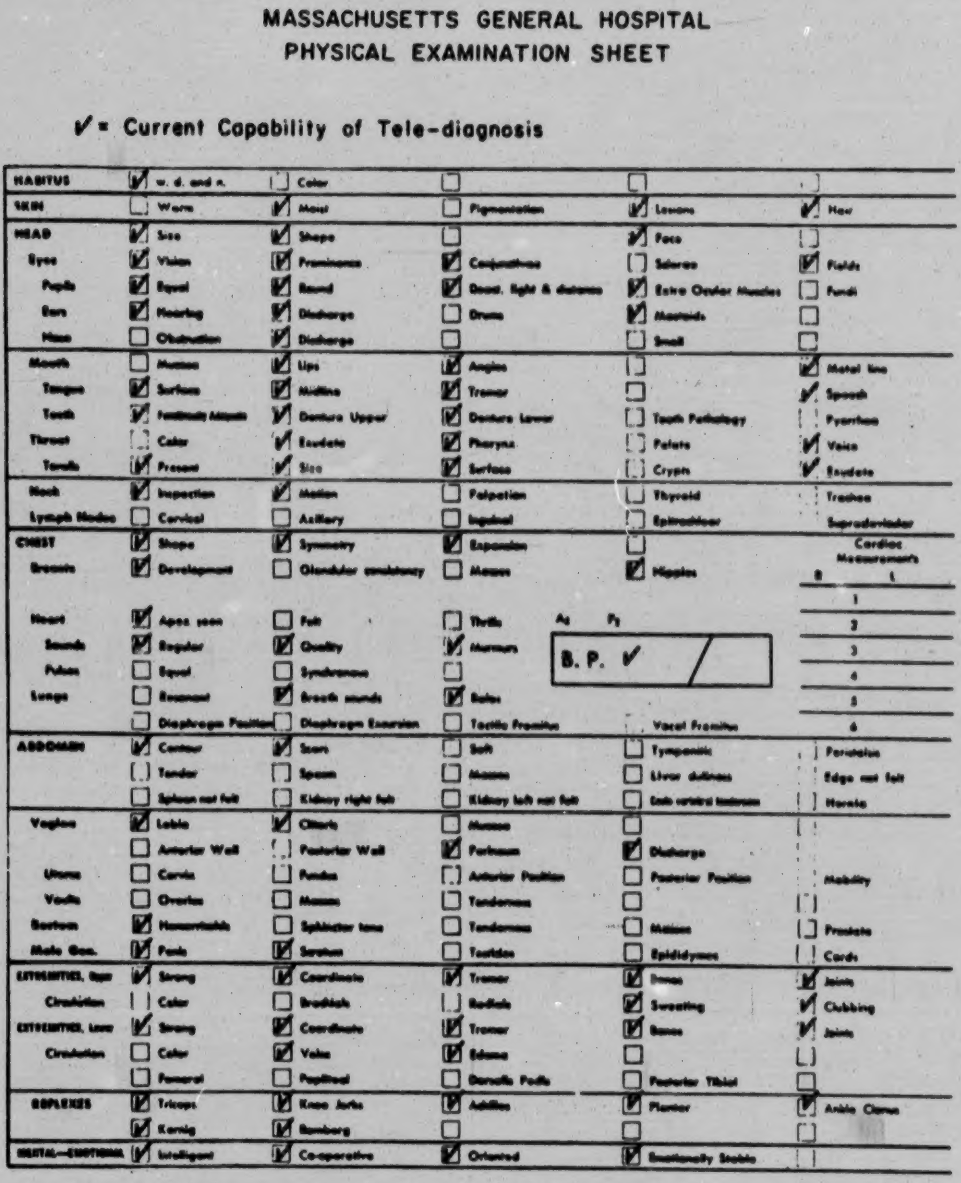
The assessment of the individual tasks which comprise telemedicine reveals important information about the types of procedures which can be successfully performed, as well as a guide to the limitations which may be inherent in the technology. Both are vital to the determination of the optimal mixture of personnel training and technology required for the delivery of care via the telemedicine scheme.

Most of the systematic studies of telemedicine performed up to the present time have been evaluations of telemedicine for specific medical tasks. These include: general diagnosis, psychiatry, radiology, dermatology, speech therapy, cardiac auscultation, anesthesia, and laboratory tests.

6.1 FEASIBILITY OF GENERAL DIAGNOSIS

"General diagnosis" encompasses the processes involved in the assessment of a large number of medical conditions. These include those that are based on visual observation and those that require physical contact. With equipment of sufficient quality, most of the former can be performed via telemedicine; while the latter require the assistance of a physician's assistant. Among the medical tasks included in the visually observable group are "evaluation of respiration, posture, physique, constitution, nutritional state, severity of illness, emotional state, complexion, scars, head exam, eyelids, external nose, lips, chest contour and symmetry, chest expansion, respiratory rate and rhythm, breast inspection, extremity range of motion, spine inspection and mobility, inspection of the teeth, pulse rate and rhythm, auscultation of the lungs for gross breath sounds, and evaluation for edema." (4) (See Figure 8.) Wempner, et al., also state that the following tasks in critical diagnosis involve the assistance of support personnel at the patient's location to help sense, interpret, and relay information that cannot be communicated via the telemedicine system alone: "color, hue, depth, resistance to palpation, fluctuance, texture, firmness, degree of pressure that brings on pain, percussion for dullness, palpation of pulse, palpation of nodules, and palpation for masses. It also includes information that can be gained from the use of an instrument that cannot be remotely operated, such as weight, height, temperature, blood pressure, opthalmascopic exam, otoscopic exam, exam of internal nose, exam of pharnx, pelvic exam, use of the stethoscope, anuscope, and proctoscope." (4) Other telemedicine systems offer the capability to perform some of these tasks because they include color cameras, electronic blood pressure monitoring devices, and fibre optic viewing devices.

Several informal evaluations (i.e., nonsystematic) have been published regarding the quality of general diagnosis, using the telemedicine scheme, but only one systematic study is available. Murphy and Bird (101) of the Massachusetts General Hospital have studied the quality of telediagnosis over the Massachusetts General



MASSACHUSETTS GENERAL HOSPITAL
PHYSICAL EXAMINATION SHEET

✓ = Current Capability of Tele-diagnosis

HABITUS	☑ w. d. and n.	☐ Color	☐	☐	☐
SKIN	☐ Warm	☑ Moist	☐ Pigmentation	☑ Lesions	☑ Hair
HEAD	☑ Size	☑ Shape	☐	☑ Face	☐
Eyes	☑ Vision	☑ Prominence	☑ Conjunctivae	☐ Sclerae	☑ Fields
Pupils	☑ Equal	☑ Round	☑ Accom. light & distance	☑ Extra Ocular Muscles	☐ Fundi
Ears	☑ Hearing	☑ Discharge	☐ Drums	☑ Mastoids	☐
Nose	☐ Obstruction	☑ Discharge	☐	☐ Smell	☐
Mouth	☐ Motion	☑ Lips	☑ Angles	☐	☑ Metal line
Tongue	☑ Surface	☑ Midline	☑ Tremor	☐	☑ Speech
Teeth	☑ Functionally Adequate	☑ Denture Upper	☑ Denture Lower	☐ Tooth Pathology	☐ Pyorrhea
Throat	☐ Color	☑ Exudate	☑ Pharynx	☐ Palate	☑ Voice
Tonsils	☑ Present	☑ Size	☑ Surface	☐ Crypts	☑ Exudate
Neck	☑ Inspection	☑ Motion	☐ Palpation	☐ Thyroid	☐ Trachea
Lymph Nodes	☐ Cervical	☐ Axillary	☐ Inguinal	☐ Epitrochlear	Supraclavicular
CHEST	☑ Shape	☑ Symmetry	☑ Expansion	☐	Cardiac Measurements
Breasts	☑ Development	☐ Glandular consistency	☐ Masses	☑ Nipples	R L
					1
Heart	☑ Apex seen	☐ Felt	☐ Thrills	A2 P2	2
Sounds	☑ Regular	☑ Quality	☑ Murmurs	B. P. ✓ /	3
Pulses	☐ Equal	☐ Synchronous	☐		4
Lungs	☐ Resonant	☑ Breath sounds	☑ Rales		5
	☐ Diaphragm Position	☐ Diaphragm Excursion	☐ Tactile Fremitus	☐ Vocal Fremitus	6
ABDOMEN	☑ Contour	☑ Scars	☐ Soft	☐ Tympanitic	☐ Peristalsis
	☐ Tender	☐ Spasm	☐ Masses	☐ Liver dullness	☐ Edge not felt
	☐ Spleen not felt	☐ Kidney right felt	☐ Kidney left not felt	☐ Costo vertebral tenderness	☐ Hernia
Vagina	☑ Labia	☑ Clitoris	☐ Mucosa	☐	☐
	☐ Anterior Wall	☐ Posterior Wall	☑ Perineum	☑ Discharge	
Uterus	☐ Cervix	☐ Fundus	☐ Anterior Position	☐ Posterior Position	Mobility
Vaults	☐ Ovaries	☐ Masses	☐ Tenderness	☐	☐
Rectum	☑ Hemorrhoids	☐ Sphincter tone	☐ Tenderness	☐ Masses	☐ Prostate
Male Gen.	☑ Penis	☑ Scrotum	☐ Testicles	☐ Epididymes	☐ Cords
EXTREMITIES, Upper	☑ Strong	☑ Coordinate	☑ Tremor	☑ Bones	☑ Joints
Circulation	☐ Color	☐ Brachials	☐ Radials	☑ Sweating	☑ Clubbing
EXTREMITIES, Lower	☑ Strong	☑ Coordinate	☑ Tremor	☑ Bones	☑ Joints
Circulation	☐ Color	☑ Veins	☑ Edema	☐	☐
	☐ Femoral	☐ Popliteal	☐ Dorsalis Pedis	☐ Posterior Tibial	☐
REFLEXES	☑ Triceps	☑ Knee Jerks	☑ Achilles	☑ Plantar	☑ Ankle Clonus
	☑ Kernig	☑ Romberg	☐	☐	☐
MENTAL—EMOTIONAL	☑ Intelligent	☑ Co-operative	☑ Oriented	☑ Emotionally Stable	☐

Adapted from M.G.H. form # 10004

Figure 8. Massachusetts General Hospital Physical Exam Sheet. From Reference (155).

Hospital-Logan Airport link, using the "population" of the airport, i.e., workers and travellers. Clearly stating the difficulties resulting from patient variability and observer variability which prevent a controlled double blind study, they compared medical diagnosis in the face-to-face and telemedicine modes. The first 200 patients examined via the telemedicine system were also examined by a physician at the medical station on the same day, to provide an independent evaluation of the patient's condition. The direct-observer physician agreed with the telemedicine physician in 96% of the cases, indicating that his own disposition of the case would not be significantly different. In the remainder of the 800 cases reported in the study, only 2% of the cases were deemed unfeasible by telemedicine, according to the telediagnosis physician. (101) This study by Murphy and Bird is a clear demonstration of the feasibility of telemedicine for the Logan Airport population where the average patient was a middle-aged white male; however, there is a possibility that there would be differences with a poor urban or rural population due to cultural variations which may influence the outcome. (See Sections 7.8 and 10.3.) In addition to the cultural differences, other telemedicine systems may vary in the available equipment and quality of the physician's assistant. (See Sections 3.3 and 5.4.) The Massachusetts General Hospital appears to excel in both areas.

6.2 FEASIBILITY OF PSYCHIATRY

For a number of years, psychiatry and other counseling professions have been using videotape for one-way transmission of learning material for the basic and continuing education of health care personnel. As the shortage of psychiatrists and other counselors grows and the demand for their services increases, new ways are being sought to extend their services. Berger, in his book on the use of videotape in psychiatry, looks ahead to the late 1970's and 1980's:

> "We are fast becoming a nation 'wired for sight and sound', with every one of the 98 million television sets in America destined to become a multiple input/output communications center. In this environment, the needs for intensified communications and effective educational and training programs in the mental health field can be most efficiently accommodated by greatly expanded application of preventive and therapeutic group procedures and health delivery services. With careful attention to creative programming and insightful use of the new technology, educators and communications in psychiatry and the mental health sciences can look to promising prospects in the Seventies and Eighties." (167, p. 257)

Telemedicine used for the delivery of psychiatric services such as diagnostic evaluation and therapy, or "telepsychiatry", is turning the above prediction into reality. As state above (Section 5.1), telepsychiatry was performed initally over the Nebraska Psychiatric Institute-Norfolk State Mental Hospital link in the mid 1960's. (30) The medical staffs of these institutions report that they have used the system for psychiatric consultations, education, ward supervision, and therapy with great success. (173, 174)

Since 1968, the Massachusetts General Hospital-Logan Airport telemedicine system has been used for patients in need of psychiatric help. Most of the patients seen in the first year represented psychiatric emergencies. After the first year, the psychiatrists began to schedule patients for consultations at the Airport Medical Station, and have seen a large number of patients since that time. The types of cases have ranged from patients with severe psychiatric disorders (approximately 5%) to diagnostic interviews, with the vast majority being cases of persons in acute situational crisis. The disposition of cases seen at the airport medical station has included treatment using interview technique alone or with prescribed drug therapy, brief intervention in acute crises, and prolonged supportive and explorative therapy for some patients with a character disorder or with a frank psychosis. Group therapy has also been quite effective, although it required a modification of the system described above. (2) (See Section 5.3.)

In the period since psychiatry was initially performed over the Massachusetts General Hospital - Logan telemedicine link for persons in the airport population, its use has expanded to reach more members of the community. The local schools, municipal courts, a prison, and voluntary youth agencies have utilized the link for a variety of counseling services. (2, 141, 144, 175) Telepsychiatry has also been made available over the Massachusetts General Hospital - Bedford VA Hospital link. (3)

The initial reaction of many psychiatrists to telepsychiatry was negative, because it was believed that the degree of personal contact with the patient would be compromised. (2) Dwyer reports that those psychiatrists who continued to use it became positive about its potential for psychiatry. He attributes the initial negative prejudice to the psychiatrist's orientation to unidirectional television, and their later acceptance to their realization of telemedicine's interactive video television characteristics. (2) However, some questions still remain in regard to what might be subtracted from, or added to, the interaction due to the electronic mediation of the communication. Some of these factors are beginning to emerge, and are discussed in Chapter 7.

The report of the Lakeview Clinic relates some experience with patients seeing a psychiatric social worker via telemedicine. Apparently, persons meeting the social worker for the first time felt uncomfortable, whereas those persons that had seen him on previous occasions seemed quite comfortable. They concluded that interaction via telemedicine systems is not uncomfortable when a trusting relationship has been built between the participants. (4) (See Chapter 7.)

The success of psychiatry via telemedicine is perhaps more difficult to assess than any of the other areas of medical care. The telepsychiatric interactions conducted to date indicate a satisfactory outcome in most cases, but further research is recommended to uncover characteristics of telepsychiatry which may differ from face-to-face interaction.

6.3 FEASIBILITY OF RADIOLOGY

Medical diagnosis relies heavily on the use of X-rays. A study has indicated that at least two thirds of all diagnoses in hospitals are made, or at least confirmed, with the aid of radiological data. (176)

X-rays are frequently taken by technicians, not physicians. Therefore, they can be produced at a remote clinic with no change in protocol. The interpretation of X-rays is performed either by physicians or specialists, e.g., radiologists, who are often not available in remote areas, or other physician-shortage areas. Thus, the X-ray, an important diagnostic tool, could add immensely to the diagnosis of a patient at a remote location if it could be transmitted through the telemedicine system. Many of the telemedicine projects have studied the transmission of X-rays, either systematically or through routine use, and have found that X-rays can be transmitted with little diminishment of quality over certain systems. (See Section 5.3.)

Andrus, Bird, Murphy, and others (176, 177, 178) have studied the transmission of 100 X-rays of patients in a tuberculosis hospital. Three physicians viewed the X-rays over the telemedicine system (with the use of a zoom lens for the quality of resolution required.) Their interpretation was compared with the hospital radiologist's interpretation and found to be in agreement in 77% of the cases. The majority of the differences were due to the tendency of the three physicians to classify disease one category greater in severity than the hospital radiologist had recorded on the patient's chart. The hospital radiologist read the X-rays in person and over the telemedicine system (6 months apart to reduce bias), and produced a 90% agreement in his diagnoses.

A study is presently being conducted between Omaha and Broken Bow, Nebraska, to determine the quality of radiological images that can be transmitted over a modified closed-circuit television link over standard telephone lines. The initial results of this study indicate that the images are remarkably good and the system is being used in day-to-day practice. (15) In the near future a new system will be installed in Omaha to allow the viewing of several X-rays simultaneously, on a case basis, rather than on individual - only basis as presently exists. (154)

6.4 FEASIBILITY OF DERMATOLOGY

The accuracy of diagnosing dermatologic conditions represents one of the best tests of the process of visual inspection via telemedicine.

(101) Two telemedicine projects have dedicated some of their time to studying this problem. Seibert, et al., of the New Hampshire-Vermont Medical Interactive Television Network studied the establishment of dermatology consultation services for a community hospital which previously lacked these services. A dermatologist, assisted by a physician's assistant at the remote location, examined in-patients and out-patients in the dermatology clinic. The dermatologist felt that she controlled the consultation adequately, and in every instance found that the skin lesion was discernible, and in all but three cases, clearly discernible. Seibert, et al, concluded that "the feasibility of delivering dermatological consultation via telemeidcine has been demonstrated, but the practicality of doing so depends on a refinement and extension of this first operational mode, i.e., the pilot study." (14)

The Massachusetts General Hospital Telecenter has done a fairly comprehensive study of "teledermatology" which was primarily concerned with assessing the reliability of black and white images (as compared to color) for diagnosing skin lesions. They experienced problems with color, light adjustments, and camera manipulations, but with the assistance of the physician's assistant, a relatively high diagnostic reliability was observed. As a part of this study, diagnosis of dermatologic conditions by internists was compared to that of dermatologists. They found that the two dermatologists interpreted 85% and 68% of the cases correctly, and the two internists interpreted 33% and 31% correctly, indicating the actual benefit of specialist consultation in the diagnosis of dermatologic conditions. (101, 158)

6.5 FEASIBILITY OF SPEECH THERAPY

The New Hampshire-Vermont Medical Interactive Television Network (14) and the Massachusetts General Hospital Telecenter (156) have both experimented with the provision of speech therapy via telemedicine. The former saw 25 children in 68 therapy sessions during a 7 month period. The speech therapist reported high satisfaction with her ability to provide speech consultations via telemedicine. In addition, she felt as though she had complete control of the situation, including her ability to assist the paraprofessional aides during the therapy.

The experiences of the Massachusetts General Hospital-Bedford VA Hospital link have been reported to have been equally as satisfying. Their speech pathologist interviewed and evaluated (via telemedicine) patients selected by the professional staff at the VA Hospital. Based on the telemedicine evaluation, therapy was initiated with staff and family members attending the transactions. Through the involvement of the staff personnel, they have observed a far better understanding of the patients' needs in regard to their speech problem. The telemedicine system has also been used to administer several diagnostic tests, with great success. These have been helpful in assessing patient progress periodically, and thus far have revealed a dramatic change in the speech and language behavior of the patients. (156)

6.6 FEASIBILITY OF CARDIAC AUSCULTATION

Cardiologists, like other specialists, are currently in short supply and geographically maldistributed throughout the United States. (See Chapter 2.) The telemedicine approach to this problem depends upon the transmission of electrocardiograms (see Section 5.3) and the specialist's ability to hear the cardiac sounds, i.e., auscultation.

To assess the quality of cardiac auscultation via telemedicine, a group composed of persons with various heart conditions and controls, i.e., no heart condition, were examined directly and via the Massachusetts General Hospital telemedicine system. To prevent bias, i.e., recognition of the patient, the video portion of the telemedicine system was turned off during the telediagnosis examination, and the physician was only able to hear the cardiac sounds. Results of the direct and telemedicine examinations were very close; 19 of the 24 heart murmers heard by direct auscultation were graded identically by the telemedicine auscultation. Allowing for normal clinical differences, this represented the accurate interpretation of all but the faintest heart murmers. In addition, some of the errors may be attributed to the location of the Logan Airport Medical Station during the early phase of the experiment. The auscultation equipment had been located adjacent to an airport runway where ambient noise was high and was later relocated to a quieter area. Phonocardiograms were also compared for level of accuracy. It was found that the phonocardiograms made via telemedicine compared favorably to the direct phonocardiogram made at the patient's bedside. (179)

6.7 FEASIBILITY OF ANESTHESIA SUPERVISION

A large portion of all anesthetics are administered by unsupervised nurse anesthetists in the United States, due to the general supply shortage and maldistribution of physician anesthesiologists. (See Chapter 2.) Gravenstein, et al. have studied the feasibility of an anesthesiologist supervising a nurse anesthetist at another location, to provide the medical expertise that is often absent. A wide variety of clinical cases were included in the study, ranging from relatively healthy patients undergoing routine procedures to a patient who died during the operation. During a full year of surgery, at least 100 clinical cases were looked at, including about 10% emergencies. They report that the system has been overwhelmingly accepted by the staff and has added a valuable specialist for consultations where non was previously available. (8)

6.8 FEASIBILITY OF LABORATORY TEST TRANSMISSION

Many routine laboratory tests can be performed without sophisticated equipment at remotely located clinics. Tests, whose results are not required immediately, can be sent to larger laboratories for analysis. However, on certain occasions it is highly desirable for the doctor to have immediate access to the test results, so that he can begin therapy based on his interpretation.

The pathologist at Bethany Brethren and Garfield Hospitals, who does most of the sophisticated test analysis for both hospital labs, is able to have results sent to him via the Picturephone system. (See Chapter 5.) A system for directly sending microscopic images over the Picturephone system is presently being developed, and it is believed that microscopic organisms will be identifiable (at the pathologist's location) if a lab technician describes the colors to the pathologist. (6)

The Massachusetts General Hospital-Logan Airport link has been using a "telemicroscope" for several years, with a rather high degree of satisfaction. The binocular microscope, multiplexed into the system, allows the nurse at the medical station to simultaneously observe the image that she sends to the Telecenter. (See Figure 5 and Section 5.3.) The peripheral blood smear and urine sediment, in addition to other specimens, can be clearly visualized by the "telemicroscope." (101, 155)

6.9 EFFECT OF TELEMEDICINE ON TIME SAVINGS

The actual effect of telemedicine on available physician time is not clear at the present time. There is some indication that telemedicine transactions may take longer than face-to-face interaction. (4) Consultations performed via television have also been found to be substantially and significantly longer than those carried out by telephone alone between the physician and the physician's assistant in the Cambridge Hospital project. (157) The additional time required for telemedicine transactions may be due to the extra time consumed in initiating the transaction, the increase in the amount of information available for medical decision-making, the participation of the patient, and the time required for the interactants to adjust to the interaction by television. In some of the projects the physician must be paged in one part of the hospital when a consultation is required, and time is consumed in going to the location of the telemedicine equipment. (157)

The overall time consumed in the telemedicine transaction may also depend on the level of training of the physician's assistant and the level of trust and respect which exists between the physician and the physician's assistant. If the physician does not have faith in the abilities of the physician's assistant, the diagnostic examination may take longer to perform, because the physician must be more convinced of what the physician's assistant says. If the physician's assistant's training is deficient for the particular task, valuable time may be wasted as the physician explains the procedure. However, the video channel would probably give the physician more confidence in his medical judgment than a telephone consultation would.

The attitudes of physicians towards telemedicine will have to undergo some modification if the potential benefits of telemedicine are to be realized. For example, some of the doctors of the Lakeview Clinic felt that their schedules were interrupted by the telemedicine transactions, because they were not scheduled beforehand. (4) A similar problem is likely to exist in any situation in which the physician is expected to cover a remote clinic via telemedicine in addition to his regularly assigned duties at the central medical facility. The Mt. Sinai School of Medicine telemedicine project has prevented this from occurring by having the telemedicine physician remain at the site of the telemedicine equipment during the time that he is on call for the remote clinic. This arrangement also guarantees an immediate consultation when such is requested by the remote clinic, because the physician is standing by. (134)

A time-study expert has recently calculated that a physician who earns $50,000 per year lowers his income by $6,250 per year if he "wastes" an hour per day on the telephone. (18) If this type of attitude is extended to telemedicine, and proper compensation is not made, telemedicine may not become a structured part of the physician's routine, and thus, may never really find a permanent place in medicine. This problem may become more apparent in the future when a physician may service more than one remote clinic via telemedicine, in which case he may be faced with a choice of treating a live patient, or a telemedicine patient at more than one clinic. How he decides his priorities may clearly reflect the status of telemedicine. The status of telemedicine in the future is likely to be determined by a combination of government, health care institution, and individual physician attitudes and actions. One might envision the government offering incentives to physicians who would deliver medical care to shortage areas via telemedicine in the future, in a manner similar to the contemporary incentives for practice in shortage areas.

Overall, if properly integrated into medical practice, telemedicine may save the physician and the patient a considerable amount of time. The patient will save time by:

(i) Not having to travel as far to receive care.

(ii) Avoiding needless trips to distant specialists.

(iii) Not having to travel to specialist's office for follow-up cases.

The physician, who presently does not usually travel to the remote area may save time more on a local level, giving him more time to devote to patient care. This would be due to the:

(i) Screening of noncomplicated cases by the physician's assistant at the remote clinic.

(ii) Availability of preliminary examination records, and laboratory test results when the physician sees the patient for the first time.

(iii) Physician's ability to check on hospitalized patients' tests, consultations, and physiological signs from a remote location (e.g., his office).

(iv) Reduction of physician travel time within the physically separate facilities of a large medical center, or group of affiliated hospitals.

The Lakeview Clinic, in its study of the effect of telemedicine on rural group practice, has found that in approximately one-fourth of the cases involving telemedicine, the physician would have been required to travel if the telemedicine system was not available. Nine out of ten health care providers at the Lakeview Clinic felt that travel was probably saved for them and half felt that a time saving had occurred. (4)

The Lakeview Clinic is composed of a group of health care providers that provide health care for the residents of a defined area, which is not very large when compared to many other rural areas. It is therefore feasible for the physicians to conduct office hours at the clinics, an arrangement which may not exist in other more isolated areas. Despite the availability of the physicians at the satellite clinics, there are still time periods in which it is desirable to see a patient at the clinic but when no physician is available at the clinic. During these periods patients have been seen by telemedicine, mostly for follow-up exams. Although no formal study has been performed, individual case histories in the Lakeview Clinic's report indicate that patients have avoided needless travel due to the availability of the telemedicine system. The Lakeview Clinic study has also found that physicians and specialists are more available for consultations than they had been before the installation of the cable system. (4)

The Blue Hill (Maine) project, which utilizes a physician's assistant at a remote clinic, reports that during its first year 2,914 clinic visits were recorded. Had the telemedicine system been unavailable, the people of Blue Hill would have to travel 60 miles round-trip to obtain medical care. (1) Although many of the project reports do not contain specific figures on time-savings for patients and physicians, the general impression of the medical personnel is that telemedicine is decreasing unnecessary travel time in many cases. A decrease in travel also represents a monetary savings either in car-fare or gasoline consumption.

7. SOME SOCIAL-PSYCHOLOGICAL CONSIDERATIONS OF TELEMEDICINE

The successful utilization of the man-machine interface required in telemedicine will most likely depend in part on a clearer understanding of human communication than we presently possess. Until quite recently, research has concentrated almost exclusively on the engineering aspects of the man-machine interface, largely ignoring what may be termed the "basic components" of human communication. Studies conducted in the past have generally been concerned with the individual as an operator of the machine, and have not considered the individual as a communicator attempting to achieve his communication goals. (181) In addition, almost no research has been done to understand man's communication by any other means than face-to-face communication. Reid, in his report for the Sloan Commission, relates his observation that out of a total of several thousand references contained in books on communication and social interaction, none are concerned with communication in any mode but face-to-face, with no machine intermediary. (181)

In the period since Reid's report, researchers have begun to investigate the components of human communication and the effects of introducing electronic devices into the communication channels to "extend" them. This research has been mainly concerned with the effect of these telecommunications devices on the structural aspects of human communication, the behavior of the participants, and what may be loosely termed "the meaning" of both. Concurrently, technologists have continued to develop and implement new telecommunications systems with little apparent concern for the findings of certain social-psychological studies. The consequence of this dichotomous approach is the present state of ignorance in regard to the social and psychological aspects of human interaction via telecommunications systems, as well as an insufficient realization of the capabilities and limitations of the persons using these systems.

A significant portion of innovation in the telecommunications field has been in the delivery of health care. In a short time period, telemedicine has grown from one field experiment to at least 24, while our understanding of the technology's effects on human behavior has not kept pace. In short, we simply do not know what the substitution of video telecommunications for face-to-face communication may do to communication behavior. One may conclude, however, that the effects would include all of the alterations in general communication behavior in addition to those that may be peculiar to medical communication.

Telemedicine is intended to substitute for written, telephone, or face-to-face communication. In assessing its social-psychological impact we should consider each of these communication modes on a scale of importance. Weston and Kristen explain that "the more sensory channels that are unavailable in a mediated communication system, the less the variety of communication cues. The quality and diversity of data available for processing is greatest in face-to-face communications, less in video systems, and least in audio systems." (182) Substitution of telecommunications for written communication, e.g., the transmission of prescriptions via telefacsimile devices, is likely to have very slight effects, mostly on the speed and convenience of information transfer. Replacement of telephone communication as it exists today by video telecommunications probably represents an improvement for some applications, because it adds some additional channels, in addition to concurrent visual feedback. However, there may be some types of health care services for which the additional cost of telemedicine is not worth the advantages that it would appear to hold over the telephone. (See Section 5.6.) In addition, Janofsky reports that in her comparison of the telephone and face-to-face interviews with psychiatric patients she observed no differences in participants' self-disclosures, i.e., total self-references and affective self-references. (183) However, we must remain aware of the nature of the psychiatric interaction; it is more than answering questions, and it involves rather complex feedback cues, whose importance may not have been fully realized in the Janofsky study. Studies by members of the Communications Studies Group of University College London (184, 185, 186) have found that there are significant differences caused by the media when the tasks are more complicated than simple information exchange. These are discussed in more detail in Section 7.5.

The substitution of video for face-to-face communication represents an important consideration in this study. Essentially, we are asking if any telecommunications technology can come close enough to face-to-face communication to make it acceptable for its intended purpose. It is presently inconceivable that any technology will "duplicate" the face-to-face interaction exactly, so the task at hand is to evaluate these differences and to evolve appropriate compsensatory behaviors to minimize the effects of these differences, or to place suitable limitations on their use.

The available literature contains remarkably little pertaining to the issues outlined above. In fact, the only report known to the author which directs itself precisely to the social-psychological aspects of telemedicine is a "working paper" by Williams of the Communications Studies Group of University College London. (31) Unfortunately, the report was written in 1972, when there were less than a half dozen telemedicine systems in operation. Consequently, many of the field observations that are available today were not yet available. The reports produced in the interim period, mostly by project directors, reveal a strong belief in the high quality of telemedicine but none have directly addressed the issue of basic, probably rather subtle, alterations in human communication behavior that may result from telemedicine. The reports, mostly prepared by physicians and engineers, approach the evaluation of telemedicine from a "clinical" perspective, of general observation and evaluation, rather than the systematic analysis of behavioral components. From the point of view of the engineer and the physician, basic communication studies may be esoteric, because telemedicine "works", and provides better health care than what had previously been available.

Despite the general lack of attention afforded these issues in the past, there appears to be some new interest developing. The first research projects dealing systematically with the interaction of participants in telemedicine are just beginning. Several National Science Foundation RANN (Research Applied to National Needs) Grants to study the delivery of social services via two-way cable television in cities have been awarded, and a study of human interaction via telemedicine is planned by the Alternate Media Center of New York University. (35)

The need to conduct these studies is becoming more apparent as the use of telecommunications increases. Our lack of understanding of human communication may result in situations in which people may feel uncomfortable. In business or personal situations this may cause an undefined uneasiness, or perhaps prompt responses manifest by modification of behavior. (148, 187) In medicine, this modification of behavior may not be acceptable, in terms of its effects on the quality of care delivered. The following sections review the available knowledge on these issues, beginning with a characterization of the expectations of the participants in the doctor-patient interaction.

7.1 DOCTOR-PATIENT INTERACTION

As the trend towards specialization in health care continues and physicians join group-practices, the traditional "doctor-patient relationship" will undergo change. (188-191) Wilson indicates that this significant change in the pattern of medical care delivery "will accompany other major changes in our society." (100) This type of observation is important in preparing to cope with the changes, but is probably not as significant as the actual strain that these changes are presently exerting on the communication between doctor and patient. In other words, the strain on communication may begin to have a significant effect on the outcome of medical care, as some allege it already has.

Somers states that "the patient's complaint as to the difficulty of establishing a meaningful relationship is probably the most widely expressed criticism of health care today." She continues, "Some would-be reformers dismiss this complaint as sentimental nostalgia with no justification in the day of scientific medicine." (188) Indeed, these reformers may be quite mistaken in their perception of health care needs, given the fact that over half of the time for medical care delivered by primary care physicians is consumed in the treatment of complaints of a psychological nature. (189) The trend towards specialization brings with it the tendency to view the patient "by parts", rather than the sum of the parts. (188) This attitude on the part of health care providers initiates, or aggrevates, a feeling in the patients that the physician is uninterested in them as a person. In reviewing a series of real doctor-patient interviews, Freidson observed:

> "In the interview the words 'curt' and 'abrupt' recur again and again as epithets describing uninterested physicians. These words sometimes occurred in a context in which the patient apparently had no desire to communicate anything he had not already communicated, and no desire for additional information. In such a context the epithets imply that the physician is not acknowledging them as significant beings, and is working mechanically rather than with interested and sympathetic concern for their difficulty." (190, p. 51)

The importance of the clinician's warmth in regard to psychological problems is supported by Truax, et al., who have demonstrated that a therapist's empathy, warmth, and genuiness are causally related to the degree of patient improvement or deterioration. (192) Related to the need for a warm and empathic doctor, is the patient's desire for a permanent physician: "Others...felt that the lack of a long-term physician implied lack of opportunity to develop a personal relationship." (190, p. 61)

Thus, all is not well with the face-to-face doctor-patient relationship, as summed up by Korsch and Negrete:

> "The quality of medical care depends in the last analysis on the interaction of the patient and the doctor, and there is abundant evidence that in current practice this interaction is too often disappointing to both parties." (189)

To determine the pattern of doctor-patient interaction, Korsch and Negrete conducted a study at Children's Hospital at the University of

Southern California School of Medicine. (189) Their group of subjects included the mothers of 800 children brought to the clinic, who had never met the participating physician before, to keep the interaction uncomplicated by previous contacts. Their methodology included a review of taped doctor-patient interactions, followed by interviews of doctors and patients' mothers. They observed that 24% of the mothers were moderately or highly dissatisfied with the interaction, that 20% said that they had not received a clear statement of what was wrong, and that almost half were still wondering what had caused their child's illness after speaking to the doctor. The real significance of these findings is found in Korsch and Negrete's conclusions: Due to the physicians' lack of communication and their frequent use of medical jargon (e.g., one mother though that "lumbar puncture" meant draining the lungs) only 16.7% of the highly dissatisfied mothers complied with the doctor's orders, while 53.4% of the satisfied mothers did. In the follow-up interviews with the mothers, a frequently expressed complaint was the failure of the doctor to fulfull their expectations of warmth, friendliness, and interest in their child. An analysis of the conversations revealed that less than 5% of the physicians' conversation was "friendly in nature"; most of it was devoted solely to technical discussion of the case.

Perhaps the most significant finding in terms of communication was the physician's frequent disregard for the mother's account of what chiefly worried her about the child's illness. They report that 26% of the mothers didn't even mention their greatest concern to the physician because they didn't have an opportunity to, or were not encouraged to do so. Under these conditions, there was often a complete "communication breakdown." Some patients apparently were so preoccupied with their predominant complaint that they didn't even hear what the physician said. In the cases of communication breakdown, the physicians sometimes fell into the pattern of repeating statements several times and openly displaying irritation and impatience.

These behavior patterns are not especially surprising in light of some doctors' attitudes. Morrison's (cited in (148)) observations on five generalized behavioral qualities that compromise the practice of medicine include:

(i) Doctors don't like to wait.
(ii) Doctors don't listen as much as they should.
(iii) Doctors don't explain things very fully.
(iv) Doctors don't like to visit other people's homes.
(v) Some doctors get bored doing the same thing over and over again and as a result don't do these things very well.

These would seem to support Korsch and Negrete's (189) observations, and are supported by Newitt's (193) findings on the things that some doctors find most irritating, including:

(i) Patients telephoning about every minor ache and pain.
(ii) Patients wanting the doctor to listen to all of their problems.

In short, communication between patients and doctors may have weaknesses that many "everyday" face-to-face communications don't appear to have. Korsch and Negrete believe that medical schools could improve this situation if they taught the students the importance of communication skills. (189) However, there does not appear to be any trend in that direction at the present time. As we look towards the future, we must begin to project these problems onto a new scheme of health care delivery: telemedicine. This entails a consideration of the strains that might add to or detract from the present state of affairs. Dittman, commenting on telecommunications, states that "the nature of the extending device will impose limits on the sort of message the source person can send and the user person can detect, and will thus affect the channel encoding and decoding processes with both persons." (194, p. 23) The effect of telemedicine on doctor-patient communication may be positive (i.e., improve doctor's attention) or it may cause more frequent "communication breakdown." At present, we simply don't know which, because basic research has not been extensive in this area. A review of the past, present, and future trends should help to suggest the possible outcomes.

7.2 EXPERIENCES WITH TELEMEDICINE

The persons developing telemedicine systems, although apparently not directly studying the components of communication, at present, remain aware of their importance. Dr. Kenneth T. Bird of Massachusetts General Hospital observes that "verbal exchange is normal. It is neither artificial nor forced, but natural", and that "bidirectional television permits a dynamic interaction which allows interpersonal communication across distance to recreate, and even enhance, face-to-face communication. Non verbal communication or the silent language which contributes heavily to the understanding, is also clearly seen and appreciated. The dramatic communication effectiveness with ready patient and professional acceptance of interactive television only stimulates attempts to understand the nature of the process more completely. Man's perception and use of space as a specialized aspect of his culture is barely understood." (3)

In another report, Dr. Bird acknowledges that "the difference between normal co-presence human interaction ritual and tele-presence human interaction ritual is small or large depending on the success of the interaction. The fact is that unless specific attention is paid to the behavioral component of the teletransaction the emergence of IATV as a mechanism of health, education and welfare activities will be considerably delayed because of unfair assessments." (83) In addition, Dr. Bird states that the tele-presence transaction is different from the face-to-face transaction and that "the interruptions which will be tolerated during classical co-presence interaction becomes magnified and are translated into loss of face or disregard to face." (83) Dr. Bird also observes that due to a "multiplicity of factors, many of which remain to be assessed, the process of communication is augmented during an IATV transaction. Verbal as well as nonverbal components may be interpreted quite differently than in the normal co-presence classical type of exchange. Until some behavioral guidelines are available for users at each end of the circuit or system many false judgments about telemedicine as a vehicle of service and education delivery will be made." (83)

In the most recent annual report on the Massachusetts General Hospital-Bedford VA telemedicine syste, Dr. Bird has stated:

> "There are several uses of telemedicine circuitry in which a modification of the normal co-presence ritual,may have to be considered eventually in order to insure optimum communication. There are several broad categories of transactions which involve tele-presence. These can be classified as follows:

> patient care examination and consultation, patient (in absentia) care consultation, patient psychiatric treatment and counseling education, patient and staff supportive telecommunication data interpretation. Some of the above are individual and some are group tele-transactions. It is the individual-to-individual transactions which will require study first. In these the primary requirement is careful adherence to reasonable behavioral etiquette, maintenance of the normal confidentiality of a face-to-face exchange and an explanation for any off-camera diversion of either audio or video nature." (27)

Dwyer, also of Massachusetts General Hospital. working with telepsychiatry, observes that "it is too early to say that nothing is subtracted from the telemedical interaction as compared with real interaction in the same room, but it is certainly clear on the basis of experience thus far that a high degree of personal contact can be made between two or more individuals via IATV. It remains to be seen whether there are kinds of patients or professionals who find a crucial ingredient missing in IATV contact." (2)

The need to search for this "crucial ingredient" is important at the present time, as telemedicine gradually passes through the transition from experimental use to daily use, if we are to realize its full potential. It may no longer be sufficient to settle for subjective observations, e.g., "the non-verbal cues -- visible over the interactive television -- increased the intimacy and made the whole experience more personable." (4) It may be time to systematically study human communication behavior via telecommonications to provide guidelines for communicators on these systems. This will require the combined efforts of physicians, whose primary concern is the welfare of their patients, and social-psychologists whose primary concern is the understanding of human interaction.

In moving up from our present state of knowledge in the area of telemedicine, we must pose the question of what we expect from telecommunications. If we see telecommunications as an accurate simulation of face-to-face contact we encounter certain practical problems. Reid states that "a difficulty of such an approach is that accuracy exists along many dimensions. Wholly accurate telecommunications would involve an image that was full size, in three dimensions, and with perfectly reproduced speech. How important are these kinds of accuracy, and what is the trade-off between them?" (181)

The question facing us in regard to telemedicine is not how accurate do we want it to be, but how accurate do we need it to be to guarantee medical care of a certain quality and doctor-patient satisfaction? To begin to seek the answer it may be helpful to turn to what is known about verbal and nonverbal human communication behavior, what effects telecommunications devices have on them, and what the prospects for the future are in regard to adjusting to and compensating for the differences, in order to maximize the communications effectiveness.

7.3 COMPONENTS OF HUMAN COMMUNICATION BEHAVIOR

In a consideration of interactive television and medicine, it is important to examine the possible changes in the basic components of communication, and the ways that they may affect the messages communicated or intended, and thus, the outcome of the doctor-patient interaction. The approach adopted in this Chapter will be to describe the channels of communication, the alteration of these channels when interactive television is substituted for face-to-face communications, and the possible perceived differences by the participants.

In speaking specifically of medical diagnosis as contrasted with general communication between people, we will be concerned mostly with the patient as the encoder, i.e., displaying symptoms, verbal and nonverbal, and the physician as the decoder, i.e., interpreting symptoms to form a diagnosis. The reverse situation, with the doctor as encoder will be considered as "general communication", no different from other face-to-face communication. This distinction is made because certain nonverbal channels involved in displaying symptoms play a clear role in medical communication, but an undefined role in general communication (e.g., odor).

In discussing the physician's role as the decoder, we are actually referring to the phenomenon often termed "doctor's intuition", which is the integration of the physician's past experiences, i.e., education and clinical training, and the signals that he receives via the channels between himself and the patient. Freidson explains that "contemporary medical diagnosis still requires the direct use of several of the physician's senses, which by the direct nature of the care can only be schooled by direct practice at using them." (191, p. 166)

A recent editorial in the Journal of the American Medical Association states the following:

> "Instinct, which is knowledge born of experience (the pediatrician who can lift an infant and feel from the muscle tone, reaction, and tissue turgor whether the child is severely or moderately ill; the internist who can "sense", without being able to explain how, whether the patient he is observing is sick, or malingering, or depressed), is one of the intangible aspects of clinical judgment. Acquisition of this skill requires time, talent, and perseverance." (70)

Communication between humans is conducted along verbal and nonverbal channels. Shulman points out that much of the past research concerned with social influence assumed unjustly that written and spoken communication channels represent the major source of influence. (195) In recent years, the importance of the nonverbal channels has been stressed by numerous researchers, resulting in several systems for describing the respective channel behaviors. The issue of how the verbal and nonverbal channels combine in the encoding and decoding of messages has not been resolved. Current research is aimed at determining whether nonverbal communication represents a qualitative or quantitative change, or whether it is simply redundant information. In relating this to medical diagnosis, there is a strong temptation to conclude that the nonverbal cues are qualitatively different, as well as quantitatively different. The differential diagnosis of a particular medical condition may rely heavily on information transmitted along one channel, e.g., olfactory or haptic. In some cases, this differential information is simply unavailable by any other means, although the physician may be able to form a fairly accurate diagnosis without it (i.e., on the basis of other symptoms.) The latter would represent the quantitative aspects of nonverbal cues.

Nonverbal and verbal channels play some role in doctor-patient communication and, in some medical conditions, very distinct roles. This means that changes in any of the nonverbal channels may reduce the probability of diagnostic accuracy. A consideration of what is known in regard to nonverbal cues and the effect of introducing telecommunications into the channels may help to understand the possible changes.

Since the 1950's, studies have been conducted to systematically observe and record nonverbal behaviors, and to understand the cultural codes that guide their use and their significance in the human condition. (196) Three nonverbal modalities, proxemics (man's perception and use of personal and social space, including eye-contact and body orientation), kinesics or body motion (movement of body and gestures, posture, and facial expressions), and paralanguage (non-language sounds, voice qualities, and speech nonfluences) have received extensive treatment. (196) In addition to these three modes of nonverbal communication, there are many other including olfaction, haptic or tactile, and thermal channels, and the use of dress or cosmetics. These have been largely ignored, probably due to their more subtle nature and the difficulties that they pose to the researcher. Consequently, there is very little known about these channels, a factor that apparently contributes to the tendency of researchers to minimize their role in communication.

7.4 EFFECT OF THE COMMUNICATION MEDIUM ON NONVERBAL BEHAVIOR

Substitution of telecommunications channels for face-to-face channels, even in its limited extent to date, has caused some rather interesting changes and potentials for change in communication behavior. These are, perhaps, most evident in regard to those channels that have been considered unimportant in human communication discussed above. Their importance to medical communication, e.g., diagnosis becomes most apparent when they are unavailable, as they are in the case of telemedicine.

7.4.1 Olfactory Channel

With contemporary interactive television, the loss of the olfactory channel is complete. What may be lost in terms of general ability to communicate is unknown, because little or no research has been conducted in the area of olfaction and communication to determine the types, intensities, and significance of the emanation (i.e., encoding) and smelling (i.e., decoding) of odors by humans. (197, 198) However, medical diagnosis clearly requires the olfactory sense in the diagnosis of at least 50 medical conditions, which are characterized by distinct odors. (199, 200, 201) (In fact, at one time physicians were convinced that they could diagnose disease purely on the basis of odor, e.g., "yellow fever patients smelled like a 'butcher shop'." (199)) Admittedly, some of these approximately 50 diseases and conditions are fairly rare and unlikely to be diagnosed via telemedicine, as it is presently conceived, e.g., fairly rare metabolic disorders, such as phenylketonuria and maple sugar urine disease. However, many other conditions occur rather frequently and will be presented for telediagnosis, e.g., measles, tonsillitis, sinusitis, non-specific vaginitis, diabetes, and schizophrenia. The number of medical conditions with distinct odors has prompted Gellis to remark:

> "From all this it is clear that statements by mothers about peculiar odors of the infants will have to be taken seriously, and, in addition, the physician will do well to take a deep sniff of each infant he examines." (202)

Under the present scheme of telemedicine, one would expect the physician's assistant to describe these odors to the physician, in the same way as physical findings are described. However, this presents a serious problem, related to the lack of research in the field of olfaction and the characterization of odors. That is, we presently do not possess a clearcut classification system for odorants. Rather we say "it smells like...." (something else.) (197, 199) This means that the accuracy of diagnosis dependent on olfactory cues is a function of the physician's assistant's clinical experience, which may be insufficient under some of the present training programs and certification process. (See Chapter 3.)

7.4.2 Color Versus Black and White

A similar problem may exist in relation to the use of black and white images. Most of the telemedicine systems in operation are using black and white cameras for all but specialized studies. (See Section 5.3.) There has been very little research on the meaning of color in human communication. Reid notes that "there is no simple answer to the question of whether a full size black and white image is preferable to a small colored one." (181) He cites the cost of magazine advertising, in which the ratio of color to black and white is about 1 1/2:1. The same is also true for television receivers, for which the ratio is about 3 1/2:1, color to balck and white. (181) Color may be necessary for improved diagnosis for certain tasks in medicine (see Sections 5.3, 6.4, 6.7), but its role in general communication is simply not known. As in the case of olfactory symptoms, the physician's assistant must be relied upon to describe color when a black and white image is transmitted, a scheme which might result in inaccuracies or increased time consumption. (23) Murphy, et al. have reported a case where the physician's assistant had difficulty describing the color of a skin lesion accurately, resulting in incorrect diagnosis. (158) When a color telemedicine system is available there still may be some problems with color identification due to the nature of contemporary color television technology. The color that is transmitted is simply not exactly the same as the color would be in face-to-face examination.

7.4.3 Thermal Channel

The thermal channel is also absent in telemedicine, preventing the physician from directly receiving complete information on the patient's "thermal output." The thermal output would include the oral and rectal temperatures, in addition to the temperatures in other parts of the body that are not so clearly defined, i.e., those that may be casually observed at the physician touches the patient's body during the physical examination. The former can be related verbally by the physician's assistant, or directly via an electronic thermometer circuit. The latter, whose role in diagnosis through the "doctor's intuition" is not clearly defined, may present problems due to the lack of means for direct measurement of an absolute quantity. Once again, the physician must rely upon the physician's assistant's observation of "warm body areas" in the diagnostic process. The role of thermal sensitivity in general communication is relatively unexplored, and subsequently, its role is unknown.

7.4.4 Haptic Channel

The haptic channel, i.e., the sense of touch, is lost completely with the contemporary telemedicine technology. Consequently, many tasks related to physicial diagnosis will require the assistance of the physician's assistant. (See Section 6.1 for a complete list.) This is by for the most limiting factor imposed on the medical examination by the telemedicine technology. Whether or not compensatory actions, e.g., using a physician's assistant to perform certain tasks, allows the physician to obtain the information that he would normally obtain from the haptic aspects of the medical examination, will probably be one of the major determinants in the acceptance of telemedicine.

7.4.5 Summary of the Effects On the Olfactory, Thermal, and Haptic Channels

Medical tasks relying on the olfactory, thermal, and haptic channels cannot be directly performed by the physician. A well-trained physician's assistant must be relied upon to convert the cues on these channels into verbal information, which can be transmitted over the telemedicine system.* Other nonverbal channels are not altered in such an absolute way, but may be characterized by more subtle changes. Among these are social distance and eye-contact.

7.4.6 Proxemics

Hall has observed and catalogued the distances considered appropriate for various situations in different cultures. He has labeled them as: "Public", greater than 12 feet; "Social, far phase," 7-12 feet; "Social, close phase," 4-7 feet; "Personal," 18 inches to 4 feet; and "Intimate," contact to 18 inches. (203) Communication via two-way television means that a particular viewing distance will be defined by the design of the particular system. Because videophones (148), and at least some telemedicine systems (4), are designed for close viewing, this distance would probably fall within Hall's "personal" or "social, close" phase. Since the "normal" doctor-patient "communicating distance" has not been extensively studied, we don't know if this represents a significant change compared to face-to-face interaction. Simple observation reveals that, in face-to-face interaction, the doctor would be within the "intimate" distance at the time of physical examination, and perhaps in the "social, far" or

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*This would be in addition to the limited amount of medical information which can be directly verbally related by the patient.

"social, close" phase while interviewing the patient, or discussing his findings with the patient. However, when the television monitor is placed at a particular distance for the telemedicine transaction, the distance between doctor and patient is fixed, at least from the patient's perspective. The doctor will have the capability to "zoom" in and out on the patient with a remote-controlled camera, while the patient will observe the image of the doctor on a screen at a defined distance, with no control. (See Section 5.3.) Dickson and Bowers note the potential discomfort that may arise when the distance of personal approach is altered. (148) In the doctor-patient interaction this could become a contributing factor to the "communication breakdown" phenomenon discussed above. (See Section 7.1.)

In studying human behavior and social distance, we can also consider the reactions of people to intrusions of their personal space, and speculate what the effects of telemedicine might be. Argyle and Dean have discussed an equilibrium that may exist among physical proximity, eye-contact, and other aspects of intimacy, e.g., intimacy of topic. In such an arrangement, disturbances in any of the dimensions will result in compensatory changes along the others. Increasing physical proximity will result in reduction of eye-contact, and vice versa. (204, 205) In the telemedicine arrangement, where the physical proximity is fixed from the patient's perspective by the permanent arrangement of the monitor and the patient's stationary placement on the examination table, and the eye-contact is rather fixed (see below), disturbance of the equilibrium might be caused by increased intimacy of topic which is very common to medical transactions. The relationship between eye-contact and intimacy of topic has been demonstrated by Exline (207) and Exline, Gray and Schuette (208), who have shown that there is less eye-contact when the intimacy of topic becomes greater, and vice versa. The potential discomfort of this situation will become more clear when eye-contact is discussed below.

It is also important to note that eye-contact, body orientation, distance, and relaxation of body have been found to be significant indexes of liking an imaginary stimulus person. (206) That is, as the degree of liking is increased, the distance between subjects and the imaginary persons decreased. The implications of these interrelationships in regard to telemedicine may be great; if the fixed distance to the television monitor is small, and the patient's dislike for the physician is large, considerable strain may be placed on the interactants.

In discussing intrusions of personal space, a look at people's reactions in the face-to-face mode is warranted. In a direct study of spatial intrusion, Felipe and Sommer observed that people will compensate for close interpersonal proximity by turning away or fleeing. (209) In short, alterations in certain nonverbal behavior will cause compensation in others to maintain the equilibrium. But, what happens if certain nonverbal behavior modes are restricted or "frozen" by features inherent in the technology? If the observed equilibrium hypothesis is correct, some very unusual behavior could appear in telemedicine transactions, especially those dealing with intimate subjects. Until further research is conducted, we won't know if additional strain is placed on the doctor-patient interaction.

There is, however, another side to the issue of intrusions on personal space. The potential physical contacts which may be perceived as threats in face-to-face interaction may in fact be lessened or absent via telemedicine. For example, Dwyer observes that "experience does suggest that for some patients communication with a psychiatrist by means of IATV is easier than contact in the same room." (2) The group of patients that he is referring to is composed of schizophrenics, adolescents, and children. This effect may result from a sense of safety that the patient perceives when the therapist appears on the screen. Heilbronn and Libby have observed that non-psychiatric persons in face-to-face communication agree to cooperate more frequently than those who communicate via television and telephone, but, in actuality cooperate no more than others. (210) The concept of a perceived threat of face-to-face communication is supported by Felipe and Sommer who found that subjects in a mental hospital fled more frequently than college students when their personal space was intruded upon (209), and Sommer, who observed that schizophrenic patients are more likely to make use of "distant arrangements" when seating themselves for small group discussions. (211) If telemedicine does in fact reduce the physical threat of face-to-face communication there may be serious implications in regard to the socialization of patients to the "real" world after their telepsychiatric therapy.

Communication via interactive television may effect some changes in behavior. These changes may be due to factors such as the loss of three-dimensionality or alterations of personal space. The lack of research in this area makes this largely speculative.

7.4.7 Eye-Contact

Perhaps the most well-understood nonverbal behavior is eye-contact. Kendon (212), Argyle (205), Strongman (213), and others have observed the pattern of eye-contact in normal face-to-face conversation between two persons. In this scheme, the speaker rarely looks at the listener, but, instead, gazes off in all directions. Occasionally, the speaker looks at the listener to receive feedback and cues, and to indicate his intention to terminate his speech. The listener signals his acceptance of the offer to speak by looking away. It has also been observed that the level of emotionality between the two persons can be regulated by the amount of eye-contact allowed.

In their discussion of the videophone, Dickson and Bowers have described eye-contact patterns different from usual face-to-face communication, that have been observed. They attribute this to the tendency of both participants to gaze in the direction of the television monitor and thus, in the direction of the camera mounted adjacent to it, resulting in each one perceiving that the other is looking into his eyes for an abnormally long period of time. (148) In addition to the phenomenon of continuous eye-contact described by Dickson and Bowers is the problem of apparent inability to establish eye-contact. This has been observed by Dwyer (2) and Wempner, et al. (4), who attribute it to the positioning of the camera. Wempner, et al. explain that "the camera located on the side of the monitor caused an increased camera-to-eye monitor angle and resulted in a lack of feeling of eye-contact." (4)

Wempner, et al. and Dwyer both minimize the problem of deviated eye-contact pattern, because they have observed little patient discomfort attributable to it. Dickson and Bowers, however, point out that the abnormal eye-contact pattern that they observed probably creates tension during the conversation. (148) The discrepancy between

Dickson and Bowers and Dwyer and Wempner, et al. may be attributable to an uneasiness caused by extended eye-contact, but, which is not caused by a lack of eye-contact. However, it is difficult to accept the idea that a lack of eye-contact wouldn't cause at least some strain on the participants, in view of the importance of eye-contact in human communication, as described by Strongman (213) and Kendon (212). It seems possible that the differences in observation may be due to the lack of systematic observation of the participants behavior, and a failure to query the patients in detail regarding their uneasiness. If the alteration of the normal eye-contact pattern does in fact, cause uneasiness and create a souring attitude from the experience, we must ask what its effects might be on the already strained doctor-patient interaction. If it does antagonize the relationship, the patient might be more likely to reject the physician's advice, or not return for a follow-up appointment, as suggested by the Korsch and Negrete study. (189)

Dickson and Bowers have observed that persons generally adapt to the altered eye-contact pattern by looking away and/or positioning themselves off-screen to completely avoid this uncomfortable situation. (148) Since channel control is possessed by the doctor, i.e., he can turn the cameras on and off, focus the camera, etc., and since he will be the more experienced telecommunicator in the dyad, we should ponder the consequences of his moving off screen during a telemedicine transaction while the patient remains in view on the doctor's television monitor. This type of action could indicate to the patient that the doctor just didn't care. This would certainly contribute to the patient's frequent complaints that the doctors don't treat them as individuals. (See Section 7.1.)

Another significant eye-contact phenomenon has been described by Champness. (214) He has observed that the person tending to be the dominant one in the dyad usually looks away first, when initially exposed to the other participant. The act of looking away seemed to signal that, "I am speaking first." In the telemedicine scheme, it seems likely that the doctor will assume the dominant role, possibly adding to the tension. Early observations at the East Harlem Broadband Communications Network clinic indicates that the doctor may at first appear to be a highly authoritarian figure, or as one nurse described it, as "The Face of God!" (5, 80) Without further research, one cannot justifiably conclude a cause-effect relationship between this image and the assertion of dominance through eye-contact patterns, but the possibility exists.

The "meaning" of nonverbal behavior is not well-understood. Some insight has been gained in the areas of eye-contact, body postures, facial expression, and certain verbal and paralinguistic cues. However, "there is still little evidence of how important these functions are in terms of their contribution to effective communication." (181) While basic research is conducted toward developing an understanding of the meaning of nonverbal behavior, studies should also be performed to compare nonverbal communication on the various media, i.e., face-to-face, audio, and video. Even if the meansing, per se, is not known, differences between modalities can be observed, and people can be taught to adjust their behavior to cope with them. For example, Dickson and Bowers (148) have observed the tendency of experienced users of the videophone to be careless in their positioning of the camera, resulting in partial absence, distortion, or complete absence of visual nonverbal cues. Persons could easily be taught the importance of presenting their full image at all times. This could be extremely important in medicine, where the tendency and necessity is to focus on a specific portion of the body to examine it. Wempner, et al. have observed that doctors using the telephoto lens have a tendency to focus on one part of the body, thus blocking out other parts, and most nonverbal cues. (4) In systems with only one camera, the physicians could be taught to focus the camera on the entire person as soon as the close-up examination was completed. Of course, a two-camera system is preferred, allowing one camera for close-up examination, and one for the person. The Massachusetts General-Logan Airport System has such an arrangement. (3)

Further study of nonverbal behavior may reveal additional deviations, some of which may be rather subtle and realizable only through the careful analysis of filmed telemedicine transactions. It is interesting to note that even without understanding the subtleties of the problem, several of the telemedicine projects have reported adjustments in image size, camera location, monitor location to make the communication seem more natural. (5, 28) (See Section 5.3.) An important direction for the future will be to gain an understanding of human communications so that practical action and corrective adjustments of equipment can be undertaken from a firmer information base.

7.5 EFFECT OF THE COMMUNICATION MEDIUM ON BEHAVIOR

The Communications Studies Group of University College, London has been actively involved in comparisons of human communication behavior via various communication modes, including face-to-face, audio, and video, for about three years. Davies has found that the medium has little effect on the outcome when objective information (i.e., factual problem solving) is exchanged by pairs of individuals over telephone and face-to-face modes. (215) However, when emotional issues are involved in the experiments, the choice of media appears to have a direct effect on the outcome. Short has observed that the medium of communication is, itself, a fundamental determinant of the outcome in conflict tasks. Differences in media affect the likelihood of reaching agreement, which side wins, the nature of the agreement, the extent to which opinions change as a result of the interaction, and one's perceptions of the other person. (184) Williams has observed that individuals rate strangers more positively when they meet over media with a visual component. There is an apparent scale of positiveness, progressing from audio at the lower end, to video, to face-to-face at the top. (185) Short has found that there is a significantly greater opinion change when participants communicate over audio channels as compared to face-to-face, with video intermediate between audio and face-to-face. (185)

The research done by the Communications Studies Group has shown that the addition of a video channel to an audio-only system does not appear to have an effect on the accuracy of problem solving when the task is simply one of cooperative information exchange. However, when the task involves reaching an agreement or forming an impression of another person, the choice of media does appear to affect the outcome.

The findings of the Communications Studies Group regarding the effects of the medium of communication have been supported by the work of others. In an experiment involving a comparison of participant behavior via the face-to-face, telephone, and two-way television modes, Heilbronn and Libby report that they have observed certain behavioral effects which appear to vary significantly as a function of the medium of communication. They have observed that participants in the face-to-face mode, as compared to telephone and television, more frequently expressed a willingness to cooperate with the experimenter when asked if they would cooperate before the experimental task began. But, when the actual experimental task began they did not cooperate more than subjects who had been asked their intentions via telephone and television. Heilbronn and Libby conclude that, "this discrepancy between stated intentions and performance suggests that people interacting face-to-face find it more difficult to express opposition to a persuasion attempt when looking at a flesh and blood person in the eye, than when observing his image on a screen or merely hearing his voice." (210)

Heilbronn and Libby also expressed the belief that the work of the Communications Studies Group should be extended to include an examination of the subjects' behavior in terms of the information, i.e., to what extent does the task being studied involve the need to hide or withhold information, and to what extent does it involve the need to be tacktful, to conform, to be polite, and to avoid hurting each others' feelings. Finally, they assert that people communicate most effectively over certain channels, and that these channels should be determined for each person. (210)

In addition to the experiments dealing with dyadic* interaction, several researchers have observed the effects of the medium on group interaction. Weston and Kristen report that judgments of agreement and understanding concerning group members are significantly less favorable via the audio channel than those in video and face-to-face conferencing. Their study, with groups of six students discussing a course's structure over face-to-face, video, and audio modes, also revealed that the students least prefer, and are least confident in, judgments made after conversing on the audio mode, as compared to either of the other two. (182) Williams has found that the medium of communication has an effect on the patterns of support and dissent in group conferencing. Persons communicating via audio and video channels are more likely to support the person at their end of the link than at the other end. In face-to-face conferencing, the patterns of support are found to be random, i.e., based on other-than-rational basis. The participants in these experiments were also likely to rate the persons at the other end of the audio link as less intelligent and sincere. (216)

In short, data on the effects of the medium on communication are beginning to emerge. Preliminary findings suggest that the visual channel, i.e., nonverbal cues, may only provide redundant information in the case of simple information exchange or problem solving. However, when an agreement between participants and impression formation are involved, the media begin to affect the message. Medical transactions clearly involve information exchange and problem solving but, they also include a significant psychological component. We must remain acutely aware of the emotional exchange, agreement, and impression formation that characterize the latter. Much remains to be done towards reaching an understanding of this exchange, both in the face-to-face and electronically mediated modes.

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*Dyadic interaction refers to communication between two persons.

7.6 USER EXPERIENCE AS A DETERMINANT IN BEHAVIOR

Almost all of the telemedicine project reports have included some observations on the reactions of first-time users. Most state that the uneasiness of first-time users is minimal and short lived. (2, 4, 134, 170) Dickson and Bowers attribute the unpleasant sensation in first-time users partially to the participants shyness and unawareness of the "elaborate eye-contact ritual during conversations." (148) (See Section 7.4.) The use of a telecommunications system entails exposure of oneself, proportional to the number of channels available. The more channels offered, the more ways a person can communicate information with the number of ways increasing from the audio to the video to the face-to-face mode. A person accustomed to performing certain functions via a medium with a limited range of channels may require an adjustment period in adapting to a new medium with an increased number of channels. This may explain some of the awkwardness observed in persons using the videophone for the first time, because in many cases it substituted for the audio telephone.

In other cases, the patients were unaccustomed to interacting with their doctor in any mode but face-to-face. The extension of the channels by the telemedicine system may have been perceived as a threat to patient privacy. Whether the threat of unauthorized viewing or videotaping was real, or not, in these "days of Watergate" and government wiretapping the patient or doctor may have been responding as manifest by certain behavior. This response may be evident in at least two ways:

(i) The patient or doctor will display verbal or nonverbal behavior expressing his self-consciousness in regard to being on television.

(ii) The patient or doctor will display "guarded behavior" due to the fear of outside monitoring of the interaction, constituting a threat to their "sacred trust."

A review of the project reports reveals examples of both. Wempner, et al. observed that physicians felt that they were being spied upon when a camera was set up in the clinic hall to observe their casual consultation with each other. They also expressed the feeling that physicians were uncomfortable when they viewed themselves casually on the self-monitor, but not when they were working with a patient. (4) Regarding the threat of unauthorized monitoring, Wempner, et al. related the following anecdote:

> "A young woman was being examined in a follow-up for an abcess on the back. She remarked that she had developed another lesion under her breast and began to further undress. The physician became flustered and asked the patient to wait while he made double-sure that the cart containing the telemedicine equipment at the hospital was secure. The patient was unperturbed and continued to undress while these extra security measures were being taken." (4)

Mr. Ed Wallerstein of the Harlem-Mt. Sinai telemedicine project explained that some of the nurses involved in the project were initially very aware of viewing themselves during a broadcast. To feel more at ease the self-view monitor was covered. After several sessions via the telemedicine system they became more accustomed to the system and no longer felt uneasy about viewing themselves during the broadcast. (134)

In addition to the factors which may be related to the presence of the technology (such as those discussed in Section 7.4), the participants' self-consciousness and the fear of outside monitoring, one must consider the characteristic awkwardness of meeting someone for the first time. For example, calling someone on the telephone for the first time is often an awkward experience. Thus, it follows that telemedicine, which is a highly personalized and intimate experience, should be expected to prompt uneasiness in first-time users. The Lakeview Clinic reported that patients were uncomfortable meeting their psychiatric social worker for the first time via telemedicine but if they had met him previously, they did not feel this way. (4) Some patients also display uneasiness about being "on television" because they feel that they are not dressed appropriately or do not appear well enough to be seen by others. (134) These are reactions that are not commonly displayed in face-to-face interaction.

The "adjustment period", during which time the participant may overcome his initial uneasiness, is especially critical in telemedicine. If the patient reacts by not giving full comprehensive replies to questions or by failing to respond frankly to intimate questions, there might be a detrimental effect on diagnostic accuracy or therapeutic success. Consequently, it may be advisable to study first-time telemedicine interaction to provide a basis for coaching future first-time users and medical personnel on the most effective communication patterns.

7.7 COMMUNICATION OVERLOAD

Milgram has observed that city residents tend to block out certain communication channels when they are suffering from "communication overload", or the receiving of too many inputs simultaneously. The term "overload" is derived from systems analysis and refers to a system's inability to process inputs from the environment because there are too many inputs for the system to cope with, or because successive inputs come too fast. When overload occurs, the system adapts by setting priorities and making choices in regard to inputs. (217) Dickson and Bowers (148) cite Meier's (in press) speculation that some Americans are presently suffering from a sheer overload of information, even without interactive telecommunications playing a large role in their lives, as it may in the future. The inability of these people to cope with these massive inputs has been responded to by their escaping to places where they cannot be disturbed by the telephone and other information inputs.

Since limited experimentation has been performed to determine the relative effectiveness of various communication modalities (including face-to-face, audio, and video), we don't know whether interactive television will increase or decrease the chances for overload. (148) It is interesting to speculate that perhaps the pattern of "communication breakdown" discussed above (Section 7.1) was due to a sheer overload on the physician's input channels, and his simple inability to cope with it. His reaction was to cut off other verbal and nonverbal inputs by refusing to listen to the patients, and in some cases falling into a pattern of repeating the same phrases over and over again. If this phenomenon is, in fact, related to communication overload, there is a possibility that communication via interactive television may actually improve some types of medical care by improving the physician's level of attention through his greater control of his input channels. Dwyer's observation that some types of psychiatric patients respond better via interactive television (2) may indicate that a reduction of communication overload in both the patient and doctor may occur, due to the decreased number of available communication channels.

However, we must remain cognizant of the absolute limitation that may be inherent in telemedicine due to the complete loss of the haptic, olfactory, and thermal channels, and the distortion of other channels. The quantity of information may, in fact, be more easily handled via interactive television, but the types of qualitatively different information necessary for medical diagnosis may be insufficient. In short, telemedicine may be advantageous for certain types of therapy and diagnosis, but insufficient for others.

7.8 CULTURAL DIFFERENCES AND MEDICINE

The crossing of ethnic and cultural boundaries by extending channels electronically may, in some cases, bring a physician from a plush medical center into a ghetto or rural clinic at a remote geographic location, or on an international scale, may bring a physician from one part of the world into another, where he would never ordinarily practice medicine. As high as his medical expertise may be, there is significant possibility that problems will arise due to cultural differences. In a study of cultural differences, Samora, Saunders, and Larson found that the level of comprehension of medical terms by patients was frequently somewhat less than perfect, and that there were variations associated with such factors as age, ethnic group, and educational background. (218) The patient population that they studied had a substantially larger proportion of non-white population than the United States as a whole. This is significant in regard to telemedicine, which is envisioned for use in ghetto areas, Indian reservations, and rural areas. Korsch and Negrete also observed frequent cases of patient misunderstanding of medical terminology, to an extent that seriously threatened the patients' abilities to make decisions about themselves when required to. (189)

In addition to the problems associated with misunderstanding medical terminology, Wilson points out that American health care is largely dependent on time (e.g., self-medication and medical appointments) and an orientation towards a desirable state of affairs in the future, and that the concept of time may vary by culture. Past observations have indicated that the conceptions of time prevalent in medical institutions represent middle-class values, that are clearly not shared by persons of lower socio-economic classes. (100)

These differences may pose a significant barrier to the delivery of effective medical care via the telemedicine scheme. If a physician usually works in a ghetto clinic or rural area he is more likely to be responsive to the people that inhabit the area, than is a person being brought to the area via telemedicine. It has been suggested that the physician's assistant might mediate some of the cultural differences, to serve as a link between the doctor and patient, but just how effective such a scheme may be is unknown. Even if the language barrier is surpassed, there are still numerous problems of cross-cultural differences in the use of nonverbal cues, the exhibition of symptoms, and the basic philosophies of health care and life. In 1954, Somers stated the following:

> "When the practice of medicine involves the application of elements of the institution of medicine in one culture to the people of another, or from one subculture to members of another subculture within the same cultural group, what is done or attempted by those in the healing roles may not be fully understood or correctly evaluated by those in the patient roles. Conversely, the responses of those on the patient side of the interaction may not conform to the expectations of those on the healing side. To the extent that this occurs, the relationship may be unsatisfactory to everyone concerned." (219, p. 8)

Despite warnings such as these, satellite systems are being planned for the future, some of which may be used across cultural boundaries. In a symposium on engineering and medicine, the following statement was made:

> "...with a medical communication satellite and the air transportable diagnostic treatment module and communication module, physicians knowing native dialects along with specially trained local personnel could conceivably supervise medical care or deliver medical education anywhere in the world. For example: a physician native of India knowing the local language could, via satellite, supervise medical care by personnel in his native province in India. This would be particularly applicable in case of natural disaster or catastrophe." (220, p. 150)

In short, the studies and observations cited above indicate that cultural differences may pose barriers to the delivery of medical care by providers from one culture to patients of another culture. Exactly what impact this could have on telemedicine systems crossing cultural lines is presently not known.

8. LEGAL AND RELATED ISSUES

Innovative procedures and the redefinition of traditional roles are generally characterized by new social and legal issues. The social issues discussed in this thesis have no "clear-cut" course for resolvement; they will be "worked-out" by the complex interaction of many different interests. The legal issues related to these social issues can be handled in one of two ways: either the courts can wait until a plaintiff files a complaint for a specific incident, or legislative and regulatory processes can be applied. The retroactive nature of the former option probably is less attractive for telemedicine. If someone initiates legal action against a group of telemedicine health care providers for malpractice, it might damage the credibility of this new health care scheme. On the other hand, if the "rules" for practicing medicine according to this scheme are defined by legislation such that the limitations are more clear and there are guidelines to follow, the potential for damaging the credibility of telemedicine may be reduced. The failure to follow the "preventative" legislative route could hinder physician acceptance of telemedicine because the individual is not assured that his actions are legally protected. (See Section 10.4).

8.1 LEGAL LIMITATIONS ON THE PHYSICIAN'S ASSISTANT

In 1970 the American Medical Association's House of Delegates adopted the following working definition of the physician's assistant:

> "A skilled person qualified by academic and practical on-the-job training to provide patient services under the supervision and direction of a licensed physician, who is responsible for the performance of that assistant." (81)

The most significant legal issue facing the use of the physician's assistant for telemedicine is the interpretation of the phrase, "under the supervision and direction of a licensed physician." It is not clear whether this means the physical presence of the physician on the same premises, or whether supervision via interactive television from a physically remote location is included in this definition. Apparently, the latter interpretation is accepted by the telemedicine projects in operation to date.

Presently, the duties assigned to the physician's assistant and the limitations imposed are left essentially to the supervising physicians of the individual project. One approach adopted by supervising physicians has been the development of a clear statement of the kinds of services to be offered, along with standing orders for commonly occurring medical problems. (77) (See Table 14.) Consideration has also been given to the development of "a professional delineation of the physician-like functions that may safely be delegated to the primary care physician's assistant functioning in a setting removed from direct physical supervision of the physician." (221) However, this is not generally considered practical or acceptable because of the large variation in settings or patterns under which health care is delivered in various areas. It is preferable to leave it up to the individual parties (221), based on factors including the capability of the individual physician's assistant, and the extent of communication between the two. In states having "general delegatory" statutes this responsibility would lie with the physician, and in states with "regulatory authority" statutes this would be exercised by the State Board of Medical Examiners. (See Section 3.4 and Table 15.)

Table 14. Guidelines for Management of Estancia Patients. From Reference (77).

Problem	Source of Instructions or Actual Instructions
I. Health Care	
a. Well-baby, well-child (< 15 years of age)	Pediatric standing orders.
b. Premarital	Complete history, physical examination, hematocrit, urinalysis, tuberculin test. Discuss patient's preference re: birth control (see obstetric orders).
c. Pregnancy and birth control	Obstetric orders, adult history and physical examination on initial visit in all pregnant patients.
d. Other adult	Complete history, physical examination, cervical smear, urinalysis, hematocrit, chest x-ray, an electrocardiogram/PPD in those 45 + years of age.
II. Chronic Illness Maintenance	a. Depends on the problem; therefore, check with physician for individualized plan. b. If patient was seen before at our clinic -- 1. Review problem list on chart summary from last visit describing each problem and treatment, if any, patient is currently receiving plus any new problems which may have arisen since last visit. 2. Review new findings since last visit, such as: results of laboratory tests or electrocardiogram or x-rays; reports from physicians or hospitals.

Table 14. Guidelines for Management of Estancia Patients. From Reference (77). (continued)

Problem	Source of Instructions or Actual Instructions
III. Illness and Accident Care	
a. Emergencies	Send to Albuquerque promptly with first aid as needed. Later when patient is en route to Albuquerque or comfortable, notify supervisory physician.
b. Baby and child	Pediatric standing orders.
c. Adult	Interval history, physical examination, call supervisory physician.

Table 15. Telemedicine Projects: State Statutes Regulating Physician's Assistants. From Reference (81).

	None	(a) "General Delegatory"	(a) "Regulatory Authority"
MGH-Logan	x		
MGH-Bedford	x		
Lakeview	x		
Harlem-Mt. Sinai			x
Bethany/Garfield	x		
Case Western Res.	x		
Illinois Mental H.	x		
Cambridge Hospital (b)	x		
Blue Hill, Me.			x
STARPAHC (c)			x
Alaska-ATS-F (c) (e)		x	
Veterans Admin. (c)			
New Hampshire/Vt. (e)			x
Nebraska Radiology			x
Florida Penal Inst.			x
CTS (c) (d) (e)			
Nebraska VA			x
Farmington, Me.			x
Ohio Valley	x		
Puerto Rico (c) (d)			
Jacksonville			x
Cook County Hosp.	x		
Arizona Network (c)		x	
Boston City Hosp.	x		

(a) Defined and discussed in Section 3.4. (b) Project terminated.

(c) Not yet operational. (d) Outside of state jurisdiction.

(e) Interstate project.

In either case, however, the definition of "supervision by a physician" is not precise. This may have to be resolved in the near future by one of the two routes discussed above, either through legislation or as the result of a court decision.

A similar situation in regard to supervision exists in states which require a registered pharmacist to supervise pharmacist technicians. The Bethany-Brethren telemedicine project is using a scheme in which a pharmacist supervises technicians via the Picturephone Network. However, the project report states that it is still not clear whether this arrangement satisfies the supervision required by Illinois law. (28)

8.2 MALPRACTICE AND LIABILITY

Physician's may be reluctant to become involved with the diagnosis or treatment of cases via telemedicine as long as they have reason to believe that they may be more liable to malpractice charges than in traditional practice. This situation may exist as long as the question of whether remote care via telemedicine systems constitutes adequate supervision of the physician's assistant.

The first step towards resolving this issue is the definition of the legal restrictions on the physician's assistant. Presently, only 33 states have such statutes, and their effectiveness in regard to telemedicine may be questionable in some cases. (See Sections 3.4 and 8.1.) A survey of the location of the telemedicine projects reveals that about half of them are located in states with no statute regarding regulation of the physician's assistant. (See Table 15.)

The Health Law Bulletin of the University of North Carolina at Chapel Hill (cited in (111)), recommends the following for any physician's assistant practicing at a remote location.

(i) Amend the state's nurse-practice act to give clear assurance that specially-trained nurses can legally perform those functions that they are trained to handle in both dependent and independent settings.

(ii) Amend the state's medical-practice act to give physicians clear assurance that medical functions can be legally delegated to persons qualified to handle them.

(iii) Provide medical direction or standard procedures for all contemplated cases, clear and complete with instructions for when to consult or refer a case to a physician.

(iv) Designate, at all times, the supervisory physician.

(v) Establish a visible system of reliable and rapid communication with the supervising physician.

(vi) Maintain standardized records for each patient with established procedures for a regular review of records.

(vii) Develop clear procedures for handling and dispensing drugs under the authority of a physician. (Physician must sign all orders for drugs.)

(viii) Furnish oral explanations or written literature to all patients describing the manner of operation of the clinic and the nature of responsibilities of the physician's assistant and the supervising physician.

(ix) Obtain satisfactory liability insurance coverage for the physician's assistant, the supervising physician, and the institutional employer.

The telemedicine projects presently in operation vary considerably in their adoption of guidelines such as these.

As far as is discernible from the available literature, no malpractice suits have been brought against any of the telemedicine systems. However, according to knowledgeable malpractice lawyers, "the risks to the physician are greater under such circumstances because attorneys for plaintiffs would have good opportunity for exploiting the arrangement to the advantage of their clients." (219) The Case Western Reserve telemedicine project reports that their insurance carrier examined their system and "since there is no adverse experience with the system," requested a $4,000 per annum premium, a sum which is almost twice the premium for a single anesthesiologist at their hospital. Their attorneys emphasized forcefully that a consultation without "laying on of hands" exposes the consultant to a significantly greater malpractice risk than is engendered under normal circumstances of a patient-physician relationship. They emphasized two issues: can the medical consultant, i.e., the anesthesiologist, diagnose all contigencies as well and make decisions as well over a telemedicine link as he can if he is present in the same room? And, what would occur in a sudden equipment failure? (8)

These questions remain to be answered.

8.3 PAYMENT FOR MEDICAL SERVICES

Both government and private third-party payers impose no restrictions on payment for medical services provided by a physician's assistant, when the physician is physically on the premises where the care is provided. (87, 221) However, when the services are provided under the supervision of a physician at a remote location, problems may arise. Some third-party payers* will extend reimbursement for the services to cover such situations, but they require some assurance of the quality and safety of the services. In a report by the Mt. Sinai School of Medicine Department of Community Medicine it was stated that negotiations were underway with representatives from the State Medicaid Board to arrange for Medicaid to pay for telemedicine care. The Medicaid representatives' initial impression of the system was reportedly favorable, and hope was expressed that permission from the state would be obtained. (80) As of July, 1974 the issue remained unresolved. (134)

According to the Office of the General Counsel of the American Medical Association:

> "The physician-patient relationship is a contractual relationship. The obligation of the patient to pay a physician's fee depends on the patient's express or implied promise to do so. Generally, when a physician renders services for a patient, which are knowingly and voluntarily accepted by the patient, without more, the law would presume that the professional services were given in the expectation of being paid for, and would imply a promise to pay the reasonable value of the services." (222)

Although there have been no court decisions involving fees for medical services delivered via telemedicine, the patient's acceptance of the services would imply a legally binding promise to pay for the services.

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*Third-party payers include both private health insurance companies, e.g., Blue Cross, and government health insurance plans, e.g., Medicaid.

8.4 PATIENT PRIVACY

During the traditional doctor-patient interaction only the two participants have direct knowledge of what is communicated. Following the transaction, the physician retains complete control of the record of this "privileged communication," through moral and legal authority. Only unauthorized reading of the patient's chart can reveal the medical and personal information that the doctor has recorded.

The introduction of video taping in psychiatry and other branches of medicine (see Section 6.2) brought with it the possibility of new ways of invading patient's privacy. A videotape may contain medical and personal information as well as nonverbal and verbal information that may not normally appear on a patient's medical charts especially in psychiatry. Surreptitious viewing of the doctor-patient transaction can be accomplished by obtaining a copy of the videotape or being present without authorization in a room where the videotape is being viewed for educational or other purposes. Videotape also makes it possible to record a transaction without the patient's knowledge.

The advent of telemedicine introduces a new dimension to the danger of the invasion of patient privacy. An unauthorized person might be able to wiretap or intercept the transmission between the terminals of the system. As discussed above (Section 5.2), there are scrambling devices available to provide security against invasion of privacy, but none are perfect. In addition, in some of the telemedicine systems, it is possible for a third-party to enter the room at either location and not be detected by the person at the other terminal, making it possible to observe the person at the other end without his knowledge. (3, 223) With some experience, the doctor learns to use the cameras more effectively, giving him almost complete vision of the patients room. However, the patient does not have this control.

Due to the very serious legal, moral, and behavioral (see Section 7.6) consequences of unauthorized viewing, some of the telemedicine projects have taken significant steps to guard the patient's privacy. These include the use of electronic scrambling devices (see Section 5.2), requirements for obtaining written permission for videotaping, and at least oral permission for live-viewing by persons not directly involved in the medical care. (2, 4)

Finally, an aspect of patient privacy which has not received any attention in the literature is the use of male physician's assistants with female patients. Although not required by law, many male physicians have a woman (e.g., nurse) present while examining female patients, to protect themselves from false charges of improper conduct. The telemedicine scheme could possibly preclude the use of male physician's assistants in certain situations.

9. EFFECT OF TELEMEDICINE ON HEALTH CARE SERVICES DISTRIBUTION

The reasons physicians decide to leave certain areas, or initially not to live and/or practice in them, are complex and varied. (See Section 2.6.) Telemedicine has the potential for making certain areas more attractive to physicians by introducing professional services that are frequently unavailable. Whether the impact of telemedicine, in support of rural physicians, will be significant enough to attract physicians in light of the other cultural and social deficiencies remains to be seen.

9.1 PROVIDE SUPPORT FOR PHYSICIANS IN RURAL AREAS

Among the most frequently cited reasons given for physicians' choices not to practice in rural areas is the lack of professional contact, in the form of specialists for consultation, resources for continuing medical education, and other physicians for general professional contact. (See Section 2.6.) Telemedicine has the capability for providing all three, to some degree. The study of telemedicine in a rural group practice at the Lakeview Clinic has demonstrated that specialists' services can be made available at more than one location. (4) There are, of course, limits on the extent of the specialist examination via telemedicine, but it appears likely that preliminary consultations are feasible, and can save the patient needless travel time, while supporting the local physician. (See Chapter 6.) The Lakeview Clinic project also demonstrated the potential that telemedicine introduces for groups of physicians to support each other's professional activities. (4) Continuing medical education via telemedicine systems has been experimented with in the past (see Chapter 4) and will be more widely used in the future. (See Sections 4.2 and 5.1.) The use of interactive medical conferencing and live hospital rounds should be quite helpful to rural physicians.

Telemedicine can contribute to the improvement of health care in rural areas by providing communication between several facilities, to allow a group practice to cover a wide area most effectively. The Rural Health Associates in west-central Maine have organized a rural Health Maintenance Organization which serves a widely dispersed, large, poor population. By having several physicians, physician's assistants, and others staff central and remote facilities, they are able to provide care throughout the region in a manner flexible enough to respond to seasonal fluctuations in health care demands. Physicians have left solo-practice to join the group because they found that it increased professional contacts and educational opportunities, and gave the physicians some relief from their demanding schedules. (21) (See Section 2.6.)

9.2 CHANGE PERCEPTION OF NEED FOR DOCTORS IN SHORTAGE AREAS

Telemedicine appears to possess great potential for increasing the quantity of medical services over broad geographic areas in the future. (See Section 6.9.) In one respect, telemedicine may be "too" promising. As the technology becomes more refined, and the delivery of medical services becomes more feasible, telemedicine's use will most likely be expanded to deliver health care to more areas. As it becomes more acceptable as a scheme for health care delivery, it is possible that the criteria for selecting sites for implementing telemedicine systems may become relaxed. At some point in the future, the acceptance of telemedicine as an alternative for face-to-face health care could have the effect of diminishing efforts aimed at recruiting physicians for these areas (e.g., overall training, minority recruitment, and medical school curriculum reform). (See Section 2.7.) At that time the "social need" which may play a role in attracting physicians to shortage areas may no longer be perceived, because there will be an "acceptable" alternative available. Because it is not likely that telemedicine will ever completely duplicate the quality (both technical and humanistic) of face-to-face care, a two-layered health care system, in which one group receives primary care from a physician directly and the other group from a physician's assistant and physician via telemedicine, might result. Therefore it is vital that we carefully define areas of physician-shortage, and develop coordination of health care services to prevent the creation of new shortage areas.

9.3. REGIONAL COORDINATION OF HEALTH CARE SERVICES

The Council on Health Manpower and the Council on Rural Health of the American Medical Association have been concerned with the development of criteria for defining a medical-shortage area. In attempting this task, they have encountered difficulty in defining the area for study, and how to assess the quantity and quality of services provided in terms of the needs of the area's population. In deciding on boundaries for the health service area, they rejected political boundaries as meaningless for their purposes. They also rejected the definition of the areas in terms of public health service hospitals as had been done in the 1950's. They have finally chosen to organize their data into functional economic areas as they exist on a county basis, with professional judgment used to gauge spillover from neighboring counties. The problem of assessing quantity and quality of services required the selection of indices and their interpretation when applied. Variables involved in identifying the level of demand include the assessment of the geography of the area, socioeconomic and cultural indices, educational levels, and attitudes towards health. This information is then correlated with the existing manpower and facility resources and with the efficiency of the existing services in the area, to serve as analytic tools for the overall ultimate judgment by professionals. (78, 224)

The Committee on Rural Health and Council on Health Manpower joined in an effort with the Bureau of Health Manpower Education, National Institutes of Health, and the Health Services and Mental Health Administration (HSMHA) to identify scarcity areas in the United States. By late 1972, a total of 1,000 of the areas had been identified by the Community Health Service of HSMHA, and they estimated an ultimate total of 1500 areas will be identified. The results of this study are presently being used to determine the course of action that a particular area might pursue. (78, 224)

As the number of designated health care shortage areas increases it may become tempting to establish local health clinics with telecommunications links to the nearest source of more comprehensive medical care. However, great care should be taken to be sure that other activities to improve the health care situation are not neglected because of the availability of telemedicine. The failure to concurrently pursue other alternatives may result in an increased quantity of care with a dilution of quality.

In short, telemedicine is not a type of health care delivery system; but rather a tool for a health care delivery system which may facilitate the development of alternative models of health care delivery. To accomplish this, the numbers and types of health care personnel and the levels of sophistication of the area's health care facilities must be carefully considered in the planning. For example, the Arizona Telemedicine Network is planning to link health care facilities and personnel at the various levels of sophistication, beginning with the primary care outlets in the most remote areas and progressing upwards to the medical centers in urban areas. (25) Their plan has carefully coordinated the utilization of existing health manpower and facilities with their proposed telecommunications system. It seems likely that the full potential of telemedicine in a particular setting is likely to be reached only if telemedicine fits into the overall plan for health care delivery, rather than planning an area's health care delivery system around telemedicine.

10. ACCEPTANCE OF TELEMEDICINE

A technological innovation may be technically feasible, but unless its potential users accept it as being useful and non-detrimental for the function it serves, it may never receive extensive use. Numerous factors are involved in the acceptance of telemedicine, at different levels, and across different groups of people, i.e., patients, physicians, administrators and health planners. Based upon the telemedicine projects discussed in Chapter 5, it is possible to begin to identify factors which may influence the future acceptance or rejection of telemedicine. Although many of these factors have been identified (see Table 16), it is not clear just how they will interact to determine the ultimate acceptance or rejection of telemedicine. To complicate matters further, the ultimate outcome, i.e., acceptance, is in itself rather difficult to measure and is likely to vary among different patient populations.

Preliminary studies of acceptance have been concerned mostly with direct surveys of the affected persons, i.e., physicians, patients, administrators and health care planners. This may be an effective method for measuring the acceptance of a less complex service in a small group, but just may not work well in a large population. The rejection of a technological innovation such as telemedicine may be subtle, and thus overlooked in surveys of large populations. For example, patients may not use a particular facility if they are unhappy with the character of the services offered, or they may not return for follow-up care. In a large scale survey, the opinions of these persons might be missed, i.e., "they get lost in the crowd". Medical personnel might also reject the technology, manifest by their finding "other methods" to perform the

Table 16. Some Factors in the Acceptance of Telemedicine

Patients

- Role of the physician's assistant
- Social-psychological factors
- Appropriate medical care
- Reduction in travel time
- Monetary savings due to decreased travel time and decreased gasoline consumption
- Perceived quality of medical care
- Good community relations with clinic

Physicians

- Quality of medical care
- Legal issues
- Reliability of technology
- Time savings
- Quality of physician's assistant's care
- Cooperation of physician's assistant
- Payment by third-party payers

Administrators

- Legal issues
- Costs (in comparison to alternatives)
- Payment by third-party payers
- Effect on physician migration
- Populations served

same tasks. This was demonstrated in the Lakeview Clinic, where doctors chose not to use the system for telediagnosis, but instead found alternate ways for their patients to see medical personnel face-to-face. (4)

The studies of acceptance which may be likely to yield a broader and more accurate measurement are those which will directly survey health care providers and patients, in addition to measuring the patterns of health care services utilization. Statistics on whether persons return for follow-up care, whether persons actually go to see specialists, and population health care indices, will reveal whether the patients' replies to survey questionnaires are an accurate reflection of their actions. STARPAHC (12) and the Alaska Health Care experiment (13) plan on conducting this type of study in the future.

In Chapter 3, acceptance of the physician's assistant was examined in detail, to yield one component of the overall acceptance of telemedicine. In Chapters 6, 7, 8, and 9, the medical feasibility, social-psychological considerations, legal and moral issues, and the effect on physician migration patterns were discussed. These all combine to form an overall pattern of acceptance, which is not easily reduced to its components. Although no attempt will be made here to break acceptance down into its components, one should remain cognizant that these many interactions are simultaneously at work.

10.1 INNOVATION IN THE HEALTH CARE INDUSTRY

Innovation of technologies or new procedures involves more than just the adoption of the new; it may involve discardment of the old, possibly long-established, norms. The effects of others' experiences, first-hand experiences, and outside influences combine to determine the ultimate acceptance or rejection of the innovation. The summation of these factors is the key to the rate of acceptance.

During the sometimes lengthy period of contemplation, and perhaps limited experimental utilization, the institution or individual must carefully weigh the factor of uncertainty related to the innovation's known or unknown beneficial and detrimental effects. This process is complex, in that it encompasses the entire spectrum of scientific, professional, commercial, legal, and social influences.

In considering innovation in a particular area, it is important if not mandatory to study the social characteristics of the groups to be directly and indirectly affected. This is necessitated by the realization that technological change cannot be maximally effective unless its potential for inducing social change is recognized. It has often been observed that social adaptation is considerably slower than technological change, and that too rapid an introduction of technology can precipitate social crisis, resulting in backlash and ultimate rejection of the technology either outright or via subtle means, as described above. Considering the high costs of technologies such as telemedicine, it is critical that the innovation be constantly monitored for its capability of functioning within the social structure into which it is introduced. (108, 110, 225, 227)

The social structure of the health care industry is distinguished from other industries by several characteristics. Most significant among these is the "dual-management" found in health care institutions. Dual-management refers to the sharing of management and administrative powers by the institutional administrators and the staff physicians.

The role of the physician in health care administration may distort the logical progession of the innovation process, because the physician "gets what he wants", sometimes independent of good business practice or even logic in some cases. It is not uncommon to see projects or equipment from projects with large capital outlays lying idle in health care institutions, because the physicians initially said that the equipment was necessary. Over a period of time the purchase of the equipment proved to be wrong in timing and inappropriate for the social environment into which it was placed. (108, 163, 166, 167, 225)

In addition to dual management, the health care field is frequently characterized by the following: (68, 84, 108, 110, 225, 227)

(i) Conservatism, due to the backgrounds of the physicians.

(ii) Resistance to outside pressures for change, e.g., development of common standards, systematic approaches to health care delivery problems, resulting in inefficient duplication and/or fragmentation of services.

(iii) Physicians' fear of losing "legally and culturally" acquired final authority, manifest by resistance to new health care provider roles.

(iv) Rigid administration of health care facilities, which adds to resistance to innovations.

(v) Poor relationships between health care personnel and administrators, at different levels, fosters false threats to staff security, or adds to a degree of apprehensiveness among the staff, resulting in the ultimate failure of an innovation which may be

> attributed to "technical failure," but in fact is due to human failure.

The actual process of innovation depends largely on the social interactions among the people working with it. In a study of drug innovation, Coleman, Katz, and Menzel observed that the doctors who were more socially and professionally integrated into their local community and medical institution adopted the new drug much more rapidly than their less involved colleagues. (228) This observation highlights the importance of the informal communications network which exists within a social system. A similar network is observed within a health care institution, but is usually characterized by a more vertical communication pattern.

In a health care institution the process begins at the top (i.e., administration) and funnels down to the staff. In reorganizing the structure of a psychiatric institution, Ishiyama and Grover reported great success with their method of directly contacting, formally and informally, as many staff members as possible at all levels of the hospital administrative structure. It was their belief, which subsequent experience bore out, that they could ameliorate resistance to change by directly opposing the development of the feeling among the hospital workers that the administration was a hostile power. They avoided this by informing workers at all levels of the institution of the intended changes well in advance. Through this technique, they established a functional channel for feedback and helped maintain the workers' security. (227) Hagedorn and Dunlop concur on the importance of coordinating all persons at all levels that may have any connection to the new procedures, to convert potential competition into actual cooperation. (110)

On the administrative level it is important to set realistic and attainable goals to avoid the setback of disillusionment and disappointment. This requires an effective administration which is capable of developing and executing policy. Borsay emphasizes the great influence available to the people at the top, which can be effectively mobilized to persuade others in the institution to go along with decisions. (130) Bennett has suggested that this is most successfully accomplished by an interdisciplinary approach to the formulation, design, and institution of innovative procedures. (108)

Finally, it is the responsibility of the project administrator to be responsible for viewing the new system from an overall perspective, hopefully resulting in the anticipation of secondary and higher impacts. It is up to the person in this position to present the facts to the people below him in such a way that initial misrepresentation will not result in subsequent failure, especially if the technology is not well-proven. The administrator must also be concerned with educating those below him regarding the innovation, to ensure that their initial frustrations do not permanently preclude later usage, i.e., rejection.

No attempt will be made here to trace the process of innovation for telemedicine; it is probably too premature, and at any time a gargantuan task. This section is presented to allow us to begin to observe the process in regard to telemedicine and to gain some insight into some of the forces that influence certain actions that we label as "acceptance" or "rejection."

10.2 PATIENT ACCEPTANCE

Generalizations on the acceptance of telemedicine by patients are only valid within certain limits, due to the heterogeneity of the patient populations. For each population served with each type of medical care, there is likely to be a different pattern of acceptance, because the factors involved in determining it will be weighed differently. Perhaps the clearest example of this is the comparison of telemedicine for comprehensive health care delivery in a rural or urban medical-shortage area, with specialist consultations in a more affluent setting. Acceptance of the telemedicine scheme will reflect a combination of socioethnic attitudes towards health, the dependence of the population on the health care, and the way that the patients relate to the health care providers. The inaccurate measurement of patient acceptance of telemedicine through questionnaires (as outlined above) is due to the following factors:

(i) Patients respect physicians and may be apt to blindly accept what the physicians provide.

(ii) Due to the media's presentation of technology, and our general societal attitude that "technology improves living...", people are often awed by their first contact with a new technology.

(iii) When given an absolute choice between nothing and something (e.g., health care) human nature tends toward extending praise to the "something", with little objective evaluation.

In the report of The Lakeview Clinic some of these are confirmed in the comments made by physicians in a casual discussion of their impressions of patients' reactions to telemedicine: (4)

(i) Patients think that they are contributing to medical science by participating.

(ii) Patients enjoy attention.

(iii) Patients are interested in new things in medicine, especially when they are involved.

(iv) Patients feel that they are getting their money's worth with transmissions, particularly if they save a trip.

(v) Patients are impressed by the equipment.

The Lakeview Clinic telemedicine project directors have attempted to monitor patient reactions to telemedicine by surveying the nurses and doctors of the clinic. Approximately 80% of the health care providers felt that the bond between themselves and their patients was enhanced with television. A majority of the clinic's nurses felt that telemedicine would more definitely reassure patients, although they were split about evenly as to whether telemedicine caused apprehension in patients. (4)

Murphy and Bird of the Massachusetts General Hospital have addresed the issues of patient satisfaction and perception of medical care quality in their study of patients at the Logan Airport Medical Station, conducted by an "independent social scientist". They found that a majority of the 275 out of 343 responding were satisfied with the telemedicine transaction. A closer examination of their results indicates that 30.2% found the telemedicine transaction "slightly less or much less satisfactory than if I had seen him (the doctor) in person". 28.4% believed that the telemedicine doctor "had slightly or much less understanding of the medical problem than if I had seen him (the doctor) in person". (They attribute about 10% of the variance in attitude toward telediagnosis to attitudes towards medicine in general.) (101) Another study by the Mt. Sinai Medical Center indicated that patients kept clinic appointments at the same rates after telemedicine and face-to-face consultations. Unfortunately, only a small sampling of patients was studied, but the findings do suggest that the telemedicine system has not negatively influenced the willingness of patients to use the satellite clinic. (80)

In reviewing results such as these we are faced with the dilemma of what to compare them to. If an area has little or no local health care services, the introduction of a satellite clinic, supported by telemedicine, should vastly improve care. However, as stated above, the rejection of services may be rather subtle; and methods for effectively determining this need to be developed. The Murphy and Bird study (101), while demonstrating a respectable rate of patient acceptance, failed to indicate whether the patients were followed-up to see if they would seek face-to-face medical care following their telemedicine experience. Their failure to do this makes it impossible to verify the patients' responses regarding the quality and acceptability of telemedicine with their actual behavior. Because persons in remote areas may have noalternative like seeing another doctor in person, it is extremely important to monitor the patients in the model studies, e.g., Massachusetts General Hospital, to see if they seek other care following the telemedicine transaction to reassure themselves.

Studies of the number of persons using remote clinics supported by telemedicine provide an important index of acceptance. Both the Blue Hill Clinic (1) and the Rural Health Associates (21) have shown an increasing use of their remote clinics. This is especially significant because these clinics serve isolated rural populations which previously had little access to health care. It also raises the important issue of how far people may travel to seek an alternative to care via telemedicine. For example, a study the The New Hampshire-Vermont Interactive Medical Television Network indicated that 41% of the patients seen by a dermatologist in the telemedicine clinic would have travelled 30 miles to the Medical Center for care if the telemedicine was not available. (14) Clearly, more studies which compare telemedicine to difficult-to-obtain alternatives will be helpful in assessing the real level of patient acceptance. There is apparently some activity in this direction. In its evaluation of the Alaska Health Care Experiment (ATS-F Communications Satellite), the members of the Institute for Communication Research (Stanford University) plans to ask patients in the areas served by telemedicine whether they have had to travel to another facility for care, how their use of the health care facility compared with the previous year, whether the health care providers showed respect and concern, were they satisfied with the communication services, and many other questions to determine their acceptance or rejection of telemedicine. (229) However, Alaska's health care situation may be quite atypical.

10.3 MEDICAL STAFF ACCEPTANCE

Reports on physician acceptance have generally been filled with praise for telemedicine, indicating a fairly high satisfaction with the results they obtained. In reviewing these results, we must remain cognizant of who has conducted the studies, and what their biases and motivations might be. For example, a report by the Bethany/Garfield Picturephone Network states that:

> "There may be a very real problem common in all the projects. That is, there seems to be a strong vested interest on the part of the people who are doing the project to succeed in the sense that the telecommunication should be shown to be successful. Perhaps this is true for two reasons: (1) many of the people in the project are research people and want to succeed and get more money to continue the project and therefore they come up with answers 'yes, this was good, this was useful'. I have noticed that there is a terrific amount of logistic apparatus persuasion of working with the phone company, etc., to make it work. This makes the situation biased." (7)

We should remain aware of the possibility of biases because the project reports are frequently being written by persons who in most cases believe in the future place of telemedicine in health care delivery. On the other hand, objective evaluations by persons in the projects should certainly not be ruled out.

Factors contributing to a physician's acceptance of telemedicine (see Table 16) are as varied as the patients', and may vary depending on the individual person and the type of medical practice. Experience with the Case Western Reserve University anesthesiology experiment revealed initial doubt about the quality of supervision via telemedicine, followed by interest in expanding the system for use in linking two other hospitals. (8) The experiment in dermatology on the New Hampshire-Vermont Interactive Medical Television Network found that staff physicians readily made referrals to the telemedicine clinic, and that the dermatologist was consistently satisfied with the degree of supervision which she could provide over the link. (14)

Not all reports have been so encouraging. For example, the Lakeview Clinic reported that there was a tendency for nurses and doctors to find the transmission to be a discomforting experience if they were not at ease with the operation of the equipment. Eventually specific personnel at each location assumed charge of equipment operation, removing the burden from others. (4) Discomfort by the dermatologist of The New Hampshire-Vermont Interactive Medical Television Network was reported. She found that the inactivity was the most serious limitation of the clinic:

> "To stay fixed in a chair, seeing, directing, detecting, glued to the screen may well become a specialty of its own." (14)

There have been complaints that some physicians have not given telemedicine a "fair chance", as demonstrated by their complaining loudly about poor quality, while failing to adjust the simple controls that would correct the situation. (2) There has also been an expression of some physicians' apparent "fear of technology." These types of behavior have generally disappeared with time, as users have become more familiar with the technology. (3) However, a significant pattern has been noted by the director of the Lakeview Clinic's telemedicine project. He has observed that "no physician had enough confidence in telediagnosis to use it as the one-and-only interaction with that patient for physical diagnosis. This is true even after the physician had a moderate amount of experience in the use of the technology. Every patient with whom telediagnosis was used saw a physician in person either before or after the telemedicine experiment. It is important to remember that physicians, as a rule, are compulsive animals. It may very well be true that when it is possible to make a final disposition on a patient using remote data, the physician does not feel comfortable unless he gets all of the information he could get if he were able to see the patient in person. The anxiety created by incomplete information causes him to make arrangements to see that patient if at all possible." (4)

The physicians of the Lakeview Clinic had the option of seeing the patient at some time, a luxury that more geographically isolated doctorless communities may not be afforded. Their hesitancy to exercise the telediagnosis option without some face-to-face contact may indicate a serious barrier to acceptance in these physicians. The Lakeview Clinic's physicians were given questionnaires at the beginning of the telemedicine project to ascertain the effects that they expected telemedicine to have on medical care, and again after 12 months of the experiment. Initially 80% of the doctors believed that telemedicine would increase the quality of medical care. After 12 months experience with the system, only 40% believed that the quality of medical care had improved. (4)

In addition to genuine doubts about the feasibility of telemedicine, some doctors may reject its use due to the fear of outside monitoring, authorized or unauthorized. As described above (Sections 7.6 and 8.4) the doctor-patient interaction is a privileged communication. From the patient's point of view, outside monitoring is an invasion of personal privacy, whereas from the doctor's point of view, the potential for outside monitoring may be a threat to his independence. Freidson, in his characterization of the clinical physician, has stated that:

> "The autonomy of his status and the individualism encouraged by the demands of his work made it difficult for the clinician to either submit or participate in regulatory processes that attempt

> to assure high ethical and scientific standards of performance in the aggregate of practitioners. He wants to control the terms and content of his own work and is not inclined to want to lose that control to profession-wide, systematic auspices. In Science and Scholarship the obligation and the necessity to publish keeps one's work public and under the scrutiny of colleagues. But to the consulting practitioner, his work and its results are seen almost as a form of private property." (191, p. 184)

The Lakeview Clinic reported that there was a tendency for physicians reviewing videotapes made from the telemedicine transactions to offer a critique of the medical decisions of the participating physicians rather than on the application of the technology to the medical situation. The participating doctor was then put in a position of explaining his actions, and the intent of the videotape review was neglected. (4) Apparently, Freidson's characterization of the clinician was fairly accurate.

To illustrate the less than complete enthusiasm for telemedicine among some health care administrators, the following statement was made by Walter J. McNerney, the President of Blue Cross, in 1972:

> "We have seen attempts made by industry to use its excess capacity in callous disregard of need. One example of that was the proposal made by a large company to put a satellite over Southwest Indian territory so that problems and treatment could be televised. This investment in technical equipment and personnel would be absurd in terms of population and simple primary care alternatives." (166)

More extensive studies are indicated to determine the attitudes of health care professionals and administrators toward telemedicine. In its evaluation of the Alaska Health Care Delivery Experiment (ATS-F), the researchers of the Institute for Communication Research of Stanford University will conduct structure interviews with physicians, nurses, and physician's assistants to assess their attitudes toward telemedicine. The topics in the interviews will include the health care providers' attitudes toward local health needs, recent innovations in health care, the telemedicine project itself, assessment of the positive and negative effects of the system, and suggestions and criticisms related to the health services industry in general. (229)

11. CONCLUSIONS AND RECOMMENDATIONS

As presently conceived, telemedicine is a tool for health care providers to manipulate the health care system in a way that will create a more equitable distribution of medical care. Telemedicine is not intended to replace physicians or other health professionals. Rather, it aims to extend their capabilities by distributing centralized resources of expertise to other locations. This concept of "regionalization" of services has the potential for creating more local entry points into the health care system, at the most primary level of care. A structure such as this also allows greater control over the flow of patients into the health care system. Patients will be entering from more locations and will be screened by health care personnel at the primary level. This may have the effect of reducing overcrowding at certain facilities (e.g., hospital emergency rooms) because only the more complicated cases will be sent to the central medical facility, the others having been taken care of at the local entry point. The patients reaching the comprehensive facilities may be more likely to receive a better reception because they have already been screened, and labelled as having a "real medical problem." It seems possible that an ambulance (or any other health service) would be more efficient in responding to a telemedicine clinic, where a patient is known to be quite ill, than to a home address where the patient has not been evaluated by a health professional.

Telemedicine also makes it possible to bring the services of medical specialists and medically-related specialists into areas where they were previously unavailable. The availability of specialists via telemedicine allows the patients in these areas to reduce needless travel in cases in which the specialist decides that he does not need to see them in person. Reduction in patient travel is also realized in cases in which the medically-related specialist does not require physical contact for therapy or evaluation. Telemedicine also makes specialized services available to patients confined to institutions such as nursing homes and prisons.

Within large medical centers with facilities dispersed throughout an area, telemedicine permits administrators to be in touch with several locations, makes it possible for physicians to be in contact with specialists in other parts of the medical center, allows specialists to supervise and advise others, and simplifies the movement of patient records and test results within the facility. In many ways the problems of the urban medical center are like a rural area; transportation between facilities is often difficult and time-consuming in a city, and can be as much of a barrier to medical care as in a rural area.

There are many problems associated with health care delivery in the United States, many of which are most apparent in remote rural and urban ghetto areas. Telemedicine should not be thought of as a "cure-all", but, rather as one way to introduce or improve health care services in some areas. It cannot single-handedly change the attitudes of health care providers and consumers, nor the society in which they function. It is hoped that it can achieve some of the following:

(i) Provide health care to areas presently deficient or lacking it completely, by providing professional supervision of local physician's assistants.

(ii) Increase the overall available professional time by decreasing needless travel time, and by allocating some tasks to remotely located support personnel.

(iii) Decrease wasted patient transportation time by providing increased local services.

(iv) Improve care in shortage areas by offering specialist support for the physicians practicing there.

(v) Improve specialist consultations by making it possible for physicians to be present with the patient during consultation.

(vi) Improve or offer access to continuing medical education for physicians in remote areas by offering interactive programming, including possibilities such as live hospital rounds or lectures.

(vii) Allow physicians to be in constant contact with their hospitalized patients while they conduct their office hours at another location.

(viii) Enable clinics with presently limited hours, due to restricted physician scheduling, to remain open longer.

In the past ten years at least 24 telemedicine projects have been instituted or planned in the United States and Canada. Preliminary experiences indicate that telemedicine is achieving at least some of the objectives listed above. However, innovative applications of technologies rarely occur without affecting the existing social structure around them, especially when the technology is being used to rectify a social problem, i.e., the maldistribution of health care services.

Telemedicine is likely to be effective in improving health care only if the scheme in which it is used fits the needs of the patient and health provider populations for which it is designed. The satisfaction of these needs is dependent upon a multitude of medical, social, psychological, legal, and technical factors which have been dealt with throughout this study. This final chapter reviews the findings in each of these areas and recommends further research and actions concerning the future development of telemedicine.

11.1 MEDICAL FEASIBILITY

Several studies have indicated that telemedicine is an effective means for performing certain types of medical tasks from a remote location. These include psychiatry, dermatology, speech therapy, general diagnosis, laboratory test transmission, cardiac auscultation, radiology, and supervision of various types of medical personnel. However, certain limitations which may be inherent in the technology have been noted, due to the reduction of communication channels when a two-way television system is substituted for face-to-face communication. There is little doubt that the addition of a video channel to an audio channel allows an increased exchange of information. Therefore, two-way television represents an improvement over telephone-only communication, but, because the limitations on the extent of tasks which may be performed via each mode are not known, difficulty has been encountered in determining the optimum mix of personnel and technology. It is presently clear that due to the characteristics inherent in the technology, tasks requiring the use of haptic, olfactory, and thermal cues cannot be performed without the assistance of a physician's assistant. Limitations imposed by differences in sound and color are not presently clear. In addition, it is not clear whether new diagnostic processes will be required to compensate for these limitations. Finally, after examining the project reports presently available, it has been found that there have been no studies of telemedicine which have used baseline data on a defined population to compare the before and after indices of health.

To achieve an improved understanding in these areas, it is recommended that:

(i) Additional studies be conducted to determine the limitations on medical tasks which can be performed via the various types of telemedicine technology.

(ii) Studies be performed to determine possible modifications in standard diagnostic and therapeutic processes which may be necessary to compensate for limitations inherent in the technology.

(iii) Large-scale studies employing base-line data to measure the overall impact of a telemedicine system on a defined population be performed.

11.2 PHYSICIAN'S ASSISTANT

The role of the physician's assistant is important for certain tasks in the telemedicine scheme, as presently conceived. Due to the large variation in backgrounds and training, "physician's assistant" has become a term which collectively describes professional and non-professional health care personnel. This raises significant questions regarding the trade-off between quality care and care quantity, the extent of tasks that should be entrusted to the physician's assistant, and the legality of the physician's assistant's independent actions.

To achieve an improved understanding in these areas, it is recommended that:

(i) Studies be performed to determine the capabilities of each of the several types of physician's assistants, e.g., the professional nurse practitioner and the paraprofessional MEDEX, in the diagnosis and treatment of common medical problems.

(ii) Studies of patient and health care provider acceptance of the physician's assistant in an independent role, as contrasted with direct supervision by a physician, be performed.

(iii) Educators and project directors investigate the possibility of a special training program for "telemedicine physician's assistants", to include instruction on equipment operation, communication skill instruction, and additional clinical skills to compensate for the absence of touch, smell, color, and thermal sensitivity between the patient and doctor.

(iv) Physicians and educators develop clinical standards to guide the physician's assistant in situations in which independent actions on his part might be required.

11.3 COSTS AND TIME SAVINGS

Telemedicine systems in their current, initial stages of development are quite expensive. It is not clear how expensive they will be in the future if larger telemedicine networks are constructed and as the equipment requirements for certain medical tasks become more clear.

Telemedicine is envisioned for use in some areas with large and/or dispersed poor populations. Consequently, funds supplemental to resources of existing health care institutions may be necessary to install and maintain the telemedicine systems on an operational basis. It is presently unclear where these funds will come from once the initial project grant phase, in which telemedicine now finds itself, terminates.

Cost-benefit analyses for telemedicine may be difficult to perform, in view of the difficulty in quantifying some of the indirect social benefits and costs. However, for some areas, in view of the fact that no other health care alternatives may develop due, for example, to the failure of attempts to recruit physicians, it may be desirable to proceed with the development of telemedicine even without formal cost-benefit evaluation.

One may compare the cost-effectiveness of different combinations of technology and personnel, to determine which best facilitates the attainment of a designated level of medical care. However, specifying the demand level of care may involve difficult social judgments concerning past inequities in the distribution of care and the extent to which future health planning should strive for more equitable delivery.

In determining the costs of telemedicine, further data is needed regarding its effects on time-savings for both patients and health care workers. It is presently not known how many patients can be served by one physician's assistant, nor how many physician's assistants at remote clinics can be supervised by a single physician via telemedicine. It is also presently unclear what the effect of different levels of technology in combination with physician's assistants with different backgrounds may be on the rate at which particular tasks can be performed.

To achieve an improved understanding in these areas, it is recommended that:

(i) Additional studies be performed to determine what combinations of technology, e.g., wide-band versus narrow-band or color versus black and white, can be used to perform medical tasks at a given quality level.

(ii) Calculations and field-studies be performed to determine the number of patients that can be served by one physician's assistant at a remote clinic, and the number of remote clinics which can be supervised by a single physician.

(iii) Further studies be performed to compare the amount of time consumed in face-to-face, telephone and interactive television telemedicine transactions.

(iv) Further studies be conducted to determine the reduction of patient and physican travel time due to telemedicine.

(v) Studies be performed to determine whether telemedicine is having or may have a significant effect on the level of health in an area sufficient to warrant its costs.

11.4 LEGAL

There are still several unresolved legal issues which may pose a barrier to the acceptance of telemedicine. Although a majority of states have enacted statutes which allow a physician's assistant to practice under the supervision of a physician, none of them specifically state whether the supervising physician must be physically present at the same location as the physician's assistant. This may increase the physician's, the physician's assistant's, and the administration's liability to malpractice suits, in addition to increasing the malpractice insurance premiums. Furthermore, it is presently unclear whether third-party payers will pay for care delivered by a physician via telemedicine, because most of the payers require the physical presence of the supervising physician. Finally, since the statutes regulating the physician's assistants are state regulations, there is no specific provision for interstate telemedicine systems, a situation which may have potential for future conflicts.

To achieve an improved understanding in these areas, it is recommended that:

(i) A more precise legal definition of "supervision by a physician" be developed to specifically include telemedicine.

(ii) States which do not have physician's assistant utilization statutes adopt them.

(iii) Consideration be given to statutes which regulate interstate telemedicine systems.

(iv) A more precise delineation of the limits imposed on the physician's assistant, both in office practice and independent practice, be made.

(v) Efforts to secure payment for medical services by third-party payers be pursued further.

11.5 SOCIAL-PSYCHOLOGICAL

Observations of differences in behavior due to the direct effects of the medium of communication are beginning to emerge from both social-psychological studies and clinical practice. Although the "meaning" of these differences in behavior, per se, is not well-understood, the perception of differences imposed by the communication medium is sufficient to warrant a closer examination of the media's effect on the technical and social-psychological components of medical care.

There is some indication that face-to-face doctor-patient interaction may be subjected to stress that is not usually apparent in general communication. Because the alterations of certain non-verbal cues due to factors possibly inherent in the technology may add stress to the situation, a closer look at the precise interaction is indicated. Clinical observations have included participant uneasiness possibly attributable to alteration in the eye-contact pattern, image size, and monitor location. The lack of an explanation for these observations indicates the need for additional controlled laboratory studies to understand this better. Also, because telemedicine eliminates certain communication channels completely, whose roles we do not understand very well, we should begin to search for an understanding of their function, both in basic communication and in medical communication.

There is a great deal that we do not know about face-to-face communication, a situation which may be further complicated by the electronic mediation of the communication channels. The rapid development of telemedicine has simply surpassed social-psychological research, or as stated by Johansen and Miller:

> "New media of communications have traditionally been born of dreams of technologists and released to the general public with little thought or research concerning the likely social effects or necessary regulation. Initial development expenditures emphasize technological feasibility and dollar costs as measures of utility, with social scientific research used only in later stages of analysis." (230)

In situations in which the video component, i.e., two-way television, is added to an arrangement which previously relied upon audio-only, e.g., the telephone, there will be an increased volume of information transmitted. The possible differences imposed by the electronic medium become most significant when one seeks ways to optimize this information exchange and in situations where two-way television substitutes for face-to-face rather than telephone interaction. In the process of evaluating interactive television as a viable tool for health care delivery it is important to understand its status in relation to other means of communication for which it may be substituted.

To achieve an improved understanding in these areas, it is recommended that:

(i) Additional laboratory studies be performed on the use of nonverbal cues and the effects of the various media on communication behavior.

(ii) Laboratory studies be performed on man's use of the olfactory and thermal channels to achieve a better understanding of their role in medical communication.

(iii) Characteristics of "good communicators" be determined for use in the education of telemedicine participants to decrease the unwanted effects which may arise in communication via interactive television.

(iv) Studies of the equipment in use be continued to constantly modify its size, spacing, and placement in order to minimize any negative effects on communication behavior that are observed.

(v) Exploration of the importance and fidelity of color images in both medical and general communication be pursued.

11.6 PROTECTION OF THE PATIENT

Although telemedicine is still in the experimental stages of development, it is not too early to begin to take precautions to assure both the patients' physical and psychological well-being. It could be argued that telemedicine is no longer experimental because some patients are presently depending on remote clinics connected to central medical facilities for medical care. To assure physical safety, studies of medical feasibility have been conducted with the patients being checked face-to-face by physicians immediately following the telemedicine transaction. In some cases involving physician's assistants practicing at remote clinics, physicians have reviewed all patient records and have been available to see patients in person, at least once every week. If such a scheme cannot be arranged, i.e., having the physician travel to the clinic at periodic intervals, then arrangements should be made for the patient to get to the doctor with special provisions for emergency cases.

As patients become more dependent on the remote clinics for care the need for dependable equipment becomes more critical. There are presently no mandatory maintenance regulations to assure continuous operation of the telemedicine systems. Since there is a large amount of equipment in use, some of it rather new, it may be difficult to guarantee continuous operation of all the equipment; however, in some cases it appears that more rigorous equipment testing may have been performed before the systems were used for patient care.

The psychological well-being of the patient is most threatened by the danger of invasion of privacy, either through surreptitious monitoring of live transmissions or unauthorized viewing of videotapes. Some projects have installed electronic scrambling devices to discourage interception of the transmission, and have adopted rigid rules for videotaping and the obtainment of patient permission for viewing by others.

To achieve an improved understanding in these areas, it is recommended that:

(i) Maintenance regulations for the systems be developed.

(ii) Consideration be given to backup systems to guarantee more continuous operation.

(iii) Field-testing and laboratory-testing of all equipment be required before use with patients.

(iv) Standards for protection of privacy, including signal scrambling and patient release forms be developed.

(v) Plans for a physician to be available at the remote clinic periodically and a transportation system for routine and emergency cases to allow the patient to reach more comprehensive care be formulated and instituted for areas in which geographic barriers are not prohibitive.

11.7 ACCEPTANCE

Acceptance of telemedicine by physicians, patients, and administrators depends upon all of the factors discussed in this study. Limited surveys of acceptance have been conducted in the past, indicating a high level of acceptance by the persons queried. However, many questions remain unanswered because the populations for which telemedicine is likely to be most frequently used have not been studied extensively. In addition, the evaluations performed have, in some cases, been performed by persons directly involved in the project development, possibly influencing the types of questions asked and the ultimate results. The surveys have also generally failed to verify the responses to the questionnaires by monitoring the respondents' actions to see whether or not they seek health care from alternate sources after their telemedicine experience or whether they return for follow-up care.

To achieve an improved understanding in these areas, it is recommended that:

(i) More detailed studies, including choices of alternatives for receiving health care, be performed to measure the overall reaction to telemedicine.

(ii) More complete studies on defined populations, utilizing base-line data on health care facility utilization, be conducted to enable verification of patient responses to surveys on acceptance by comparing their responses to their actual actions.

(iii) Evaluation studies be performed by persons not directly involved in the development of the telemedicine systems.

11.8 COORDINATION AND POLICY ISSUES

As emphasized throughout this study, telemedicine is not an entity unto itself. Rather, it must function as a tool of the health care system in which it is used. This requires the coordination of a large number of diversified activities in many areas. For example, research in social-psychological labs must be coordinated with clinical observations; community reactions must be fed back to health planners and providers; reactions of participants must be relayed to system designers; recruitment of physicians and the utilization of telemedicine must fit into a regional plan; and, legal issues must be delineated by physicians and administrators and resolved by lawyers.

A health care delivery scheme involving telemedicine is only one alternative for facilitating a more equitable distribution of health care services. Under the present political, social, and economic situation it is among the most prominent of these alternatives. There is little doubt that within as yet undefined limits, telemedicine has the potential for improving health care in certain situations.

Once telemedicine is introduced and legitimized as an integral component of an alternative health care scheme, patients and physicians are likely to become increasingly dependent on it. This dependency creates the potential for a situation in which regional health care is planned around telemedicine links. Because it appears unlikely that telemedicine will duplicate the face-to-face delivery of health care, on either a medical or humanistic basis, it is vital that we carefully plan the utilization of telemedicine to avoid the development of a permanent, two-layered health care system with two different levels of quality, one for those who have access to, and can afford, conventional health care at its best, the other for those who cannot. This planning will undoubtedly require the active participation of physicians, government officials, and an informed citizenry. It is hoped that this study will contribute to that effort.

12. ACKNOWLEDGEMENT

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13. APPENDIX

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13.1 TELEMEDICINE PROJECTS SUPPORTED BY THE DEPARTMENT OF HEW LOGISTICS PROGRAM AS OF JUNE 30, 1973

Picturephone Network for the Illinois Department of Mental Health Medical Center Complex/Community Mental Health Program (HSM 110-72-381)

Dr. Lester H. Rudy
Medical Center Complex
1601 West Taylor Street
Chicago, Illinois 60612

6/30/72 - 4/30/74 '72 $30,751
'73 $41,785

The purpose of this contract is to explore the utility of a ubiquitous, instantaneous, switched visual communication system throughout a geographically dispersed health care system which includes two neighborhood mental health centers, a school for emotionally disturbed children, and three psychiatric institutes. A 12 Picturephone network has been installed to link the components of the community mental health care program to seek the elimination of communications problems which relate to (1) expediting and continuing patients in treatment; (2) providing improved and instantaneous consultation and training to paraprofessional staff in satellite operations; and (3) improving the flow of information related to patient treatment and staff efforts among the program components.

An Experiment in Using Two-Way Wideband Audio, Visual, and Data Communications Over a Laser Link to Permit an Anesthesiologist to Supervise a Nurse Anesthetist (HSM 110-72-383)

Dr. J. S. Gravenstein
Department of Anesthesiology
School of Medicine
Case Western Reserve University
2040 Adelbert Road
Cleveland, Ohio 44106

6/27/72 - 10/15/73 '72 $94,295
'73 $ - 0 -

The purpose of this contract is to explore the utility of two-way visual communication between a nurse anesthetist at the V. A. Hospital, Cleveland and an anesthesiologist at Case Western Reserve University, 1.2 kilometers away. A laser beam is being used to transmit a color television signal, sound, and physiological signals, such as the electrocardiogram. Since nurse anesthetists administer a large part of all of the anesthesia in this country, it is important to explore the question of providing remote consultation to these physician-extenders in order to assure high quality care.

Evaluation of a Video-augmented Consultation System Between Physician Extenders at Neighborhood Health Clinics and Physicians at a Community Hospital (HSM 110-72-384)

Dr. Gordon T. Moore
The Cambridge Hospital
Harvard University
1493 Cambridge Street
Cambridge, Massachusetts 02139

6/27/72 - 1/25/74	'72 $137,143 '73 $ 39,369

The purpose of this contract is to provide consultation and backup from physicians at a community hospital for nurse practitioners providing primary care in three satellite health clinics. Two-way television using microwave transmission is being used. The impact of television on the productivity and efficiency of the nurse practitioners and on the quality of the care which they provide is being examined.

Picturephone and Cable for Visual Communication and Transmission of Medical Records in the Bethany/Garfield Community Health Care Network (HSM 72-385)

Mr. Vernon Showalter
Bethany Brethren Hospital
3420 West Van Buren Street
Chicago, Illinois 60624

6/29/74 - 11/28/73	'72 $121,435 '73 $ 66,451

It is the purpose of this contract to explore the use of broadband communications technology in solving the communications problems of a large health care network in a ghetto area. The network is committed to the development of a comprehensive primary care health program to serve the residents of the medically underserved community in which it is situated. Picturephones have been installed for face-to-face communication, and a system of video discs connected by cable has been installed for transmitting medical records from one point in the network to another. The parts of the health care network affected include two community hospitals, three medical clinics, and a drug awareness clinic staffed largely by ex-addicts.

Bi-directional Cable Television System to Support a Rural Group Practice (HSM 110-72-386)

Dr. Jon Wempner
Lakeview Clinic
609 West First
Waconia, Minnesota 55387

6/29/72 - 12/28/73	'72 $132,059 '73 $ 63,109

The purpose of this contract is to explore the utility of two-way visual communication among the members of a geographically dispersed group practice in a rural area. Bi-directional cable will link the group's two clinics, one of which is in the "new town" of Jonathan, Minnesota, and the 110 bed hospital which serves the region. It is anticipated that improved care for patients will result as the services of the group's specialists can be distributed throughout the health care network, that the physicians will save time and travel, and that the physicians in the distant clinic will feel less isolated.

Two-way Television to Support Physician Extenders in Dermatology and Speech Therapy (HSM 110-72-387)*

Dr. Dean Seibert
Department of Community Medicine
Dartmouth Medical School
Hanover, New Hampshire 03755

6/29/72 - 10/12/73	'72 $60,227 '73 $ -0-

It is the purpose of this contract to do two experiments: (1) explore the feasibility of using two-way television for providing speech therapy, and (2) determine the extent to which a dermatologist can give patient care remotely by supervising a specially trained Medex. Both of these experiments will utilize an existing microwave network supported in part by the Lister Hill Center for Biomedical Communications. These experiments are important first steps in the rational development of hierarchical health care systems because they investigate manpower innovations in combination with communications technology support.

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*This contract is for only the speech therapy and dermatology experiments on the existing microwave system. The other 7 contracts include funds for system construction.

Bi-Directional Video Communication and Facsimile Reproduction Links Between a Housing Project Pediatric Clinic and the Mount Sinai Medical Center (HSM 110-72-382)

6/27/72 - 6/26/73	'72 $114,434

East Harlem Broadband Health Communications Network (HS 01392)

6/27/73 - 6/26/75	'73 $128,344

Dr. Carter Marshall
Department of Community Medicine
Mount Sinai School of Medicine
17 East 96th Street, Room 1A
New York, New York 10029

It is the purpose of this project to explore the feasibility of providing physician coverage to a pediatric clinic using two-way television over a bi-directional cable. The primary care clinic is located in a housing project in East Harlem and is staffed by one physician, two nurses and seven allied health workers. The services of the physician are not required for all cases, and the question being addressed is to what extent video contact can be used effectively and efficiently in lieu of personal contact.

Evaluation of Remote Radiographic Communication (HS 01210)

William J. Wilson, M.D.
University of Nebraska Medical Center
Omaha, Nebraska 68105

6/30/73 - 6/29/75	'73 $128,654

The purpose of this grant is to implement and evaluate a commercially available slow-scan television system for transmitting radiographs between the small rural community of Broken Bow, Nebraska, which has no radiologist, and the Department of Radiology at the University of Nebraska. Multiple images will be stored on a video disc before being read by the radiologist.

14. BIBLIOGRAPHY

1. Britt, R. W. (Project Director). "Interactive Television: Blue Hill/Stonington, Maine." Unpublished report, Blue Hill Memorial Hospital, Blue Hill, Maine, no date.

2. Dwyer, T. F: Telepsychiatry: Psychiatric consultation by interactive television. American Journal of Psychiatry, 130:865-869, 1973.

3. Bird, K. T. (Project Director). "Teleconsultation: A New Health Information Exchange System." The 03 Annual Report Veterans Administration, Washington, D.C., Certificate of Award and Agreement No. EMI-69-001, April, 1971.

4. Wempner, J. A. (Project Director). "A Bi-Directional Cable Television System to Support a Rural Group Practice." Unpublished report, Contract HSM-110-72-386, Bureau of Health Services Research, U.S. Public Health Service, Department of HEW, March, 1974.

5. Wallerstein, E., Cunningham, N., and Thomstad, B. "East Harlem Broadband Communications Network." Unpublished report, Mt. Sinai School of Medicine, Department of Community Medicine, no date.

6. Showalter, V. C. (Project Coordinator). "Telecommunications in a Health Care Delivery System." Paper presented at the Fifth Meeting of the Two-Way Visual Communication Contractors, Minneapolis, Minnesota, October 1-2, 1973.

7. Showalter, V., Muldoon, J., and Evans, G. "Picturephone and Cable for Visual Communication and Transmission of Medical Records in the Bethany/Garfield Community Health Care Network." Unpublished report, Bethany/Garfield Community Hospital, Chicago, Illinois, no date.

8. Gravenstein, J. S., Pao, Y. H., and Stickley, W. T. "Laser Mediated Telemedicine: Final Report." Unpublished report, Contract HSM 110-72-383, Bureau of Health Services Research, U.S. Public Health Service, Department of HEW, December, 1973.

9. Flynn, M. and Kroe, J. "Illinois Mental Health Institutes: Picturephone Project." Unpublished report, Illinois Mental Health Institutes, Chicago, Illinois, October, 1973.

10. Moore, G. and Willemain, T. "The Cambridge Hospital - Consultation System Between Physician Extenders at Neighborhood Clinics and Physicians at a Community Hospital." Unpublished report, Cambridge Hospital, Cambridge, Massachusetts, no date.

11. Papago Indians to get space age health care. Lockheed Doing It, May/June, 1973.

12. Personal correspondence with Dr. J. W. Justice, STARPAHC, Project Site Director, Tucson, Arizona, May 10, 1974.

13. "Health-Education Telecommunications Experiment (HET): Experiment Summary Description." Unpublished report, NASA and Department of Health, Education, and Welfare, November 1, 1973.

14. Seibert, D. J. (Project Director). "The Provision of Speech Therapy and Dermatology Consultations via Closed Circuit Television." Final report, contract HSM 110-72-387, Bureau of Health Services Research, U.S. Public Health Service, Department of HEW, no date.

15. Personal correspondence with Dr. W. J. Wilson, Department of Radiology, The University of Nebraska Medical Center, Omaha, Nebraska, November 16, 1973.

16. Sanders, J., Sasmor, L., and Edelman, A. "University of Miami-Penal System - Joint Undertaking of Westinghouse Health Systems and Jackson Memorial Hospital." Unpublished report, Jackson Memorial Hospital, Miami, Florida, no date.

17. "Telemedicine Health Care Delivery in Dade County, Florida, Penal Institutions." Unpublished report, Jackson Memorial Hospital, Miami, Florida, no date.

18. "Telemedicine Experiment." Unpublished report, Communications Canada, Ottawa, Canada, no date.

19. "Addendum to CTS Proposal." Unpublished report, University of Western Ontario - Northern Health Services, Canada, no date.

20. Benschoter, R. A.: Multi-Purpose Television. Annals of the New York Academy of Sciences, 142:471-478, 1967.

21. Hoffman, L. S.: In Family Practice, as Maine goes. Hospital Practice, 8:175-176, 181-183, 188-190, 195, 1973.

22. Ohio Valley Medical Microwave Television System News, 2: 1-4, 1974.

23. Eckerling, J. W. "Criteria for an Experiment in Health Services Telecommunications in Puerto Rico." Unpublished report, Institute of Social Technology, San Juan, Puerto Rico, December, 1971.

24. Bush, I. M. "A Ten Station Picturephone System in the Modern Delivery of Urologic Care." Unpublished report, Department of Urology, Cook County Hospital, Chicago, Illinois, no date.

25. Levinson, D., Schooley, L. C., and Decker, P. G. "A Communication System for Health Care Delivery on Indian Reservation in Arizona." Unpublished report, Arizona Medical School, no date.

26. Mark, R. G. "A Hospital-Based Nursing Home Telemedicine System." Unpublished report, Boston City Hospital, Boston, Massachusetts, no date.

27. Bird, K. T. (Project Director). "Telemedicine: A New Health Information Exchange System." The 05 Annual Report, Veterans Administration, Washington, D.C., Certificate of Award and Agreement No. EMI-72C-011-01, July, 1973.

28. "Logistics Program." Unpublished report, Health Care Technology Division, Department of HEW, 1973.

29. Crichton, M. *Five Patients*. New York: Alfred A. Knopf, 1970.

30. Kalba, K. "Communicable Medicine: Cable Television and Health Services." Report for the Sloan Commission, New York, N. Y., September, 1971.

31. Williams, E. "Telecommunications and Medicine: Impact and Effectiveness." Unpublished working paper, Ref. P/72321/WL, Communications Studies Group, University College London, London, England, November, 1972.

32. Willemain, T. R. "Planning Telemedical Systems." Report No. 77, M.I.T. Operations Research Center, Cambridge, Massachusetts, October, 1972.

33. "Telecommunications and Health Services." Report #73-144, ABT Associates, Cambridge, Massachusetts, January, 1974.

34. Personal correspondence with Ms. Patricia Armstrong, Department of Medical Care Organization, University of Michigan School of Public Health, Ann Arbor, Michigan, April 19, 1974.

35. Personal correspondence with Mr. Ben Park, The Alternate Media Center, New York University, New York, N. Y., May 8, 1974.

36. Folsom, M. In Proceedings of the White House Conference on Health, Washington, D.C., November 3-4, 1965.

37. "Accessibility to Health Services Report." Booklet, Missouri Governor's Advisory Council for Comprehensive Health Planning, Jefferson City, Missouri, February, 1971.

38. Haggerty, R. J.: What type of medical care can or should be offered to the urban poor? In Norman, J. C. (Ed.), *Medicine in the Ghetto*. New York: Appleton-Century-Crofts, 1969, 251-259.

39. "Quality in Health Care." Report of the 1968 National Health Forum, National Health Council, New York, N. Y., 1968.

40. Department of Community Health, American Medical Association. "Committee on Health Care for the Poor Progress Report." American Medical Association, Chicago, Illinois, November, 1972.

41. Lentz, J. C. "Improving Systems for Delivery of Health Care in Rural Areas." Resource Paper for Discussion Group C-1, AMA National Congress on Health Manpower, Chicago, Illinois, October 22-24, 1970.

42. Ferguson, L. A.: What has been accomplished in Chicago? In Norman, J. C. (Ed.), Medicine in the Ghetto. New York: Appleton-Century-Crofts, 1969, 87-97.

43. Powell, R. N.: What has happened in the Watts-Willowbrook Program? In Norman, J. C. (Ed.), Medicine in the Ghetto. New York: Appleton-Century-Crofts, 1969, 73-85.

44. Haynes, M. A. and McGarvey, M. R.: Physicians, hospitals, and patients in the inner city. In Norman, J. C. (Ed.), Medicine in the Ghetto. New York: Appleton-Century-Crofts, 1969, 117-124.

45. Nolan, R. L. and Schwartz, J. L. (Eds.). Rural and Appalachian Health. Springfield, Illinois: Charles C. Thomas, 1973.

46. McNerney, W. J. and Riedel, D. C. Regionalization and Rural Health Care: An Experiment in Three Communities. Ann Arbor: The University of Michigan, 1962.

47. Schwartz, J. C.: Rural health problems of isolated Appalachian communities. In Nolan, R. L. and Schwartz, J. L. (Eds.), Rural and Appalachian Health. Springfield, Illinois: Charles C. Thomas, 1973, 29-44.

48. Hudson, H. E. and Parker, E. B.: Medical communications in Alaska by satellite. New England Journal of Medicine, 289:1351-1356, 1973.

49. Edwards, J. A. and Lindsey, P.: The nurse practitioner: Idaho's experiment to improve rural health care. Northwest Medicine, November, 1972: 842-844.

50. Cooper, J. K. and Heald, K.: Is there a doctor shortage? Journal of the American Medical Association, 227:1410-1411, 1974.

51. The Carnegie Commission. Higher Education and the Nation's Health. New York: McGraw-Hill, 1970.

52. Fein, R. The Doctor Shortage, An Economic Diagnosis. Washington, D. C.: The Brookings Institution, 1967.

53. English, J. T.: Is the O.E.O. concept - the neighborhood health center - the answer? In Norman, J. C. (Ed.), Medicine in the Ghetto. New York: Appleton-Century-Crofts, 1969, 261-266.

54. Hassinger, E. W. and McNamara, R. J.: Rural health in the United States. In The Quality of Rural Living. Washington, D.C.: National Academy of Sciences, 1971, 8-21.

55. Norman, J. C. (Ed.). Medicine in the Ghetto. New York: Appleton-Century-Crofts, 1969.

56. Cook, F. J.: The doomed of Watts. In Gordon, D. M., Problems in Political Economy: An Urban Perspective. Lexington, Massachusetts: D. C. Health and Co., 1971, 320-323.

57. Bible, B. L.: Physicians' views of medical practice in nonmetropolitan communities. Public Health Reports, 85:11-17, 1970.

58. National Center for Health Statistics. "Health Resources Statistics." United States Department of HEW, Rockville, Maryland, 1973.

59. Haug, J. N. and Roback, G. A. "Distribution of Physicians, Hospitals, and Hospital Beds in the U.S., 1969." American Medical Association, Chicago, Illinois, 1970.

60. Norman, J. C. (Ed.): Introduction. In Norman, J. C. (Ed.). Medicine in the Ghetto. New York: Appleton-Century-Crofts, 1969, 131-132.

61. Lashof, J. C.: Medical care in the urban center. Annals of Internal Medicine, 68: 242-244.

62. Holloman, J. L. S.: Future role of the ghetto physician. In Norman, J. C. (Ed.). Medicine in the Ghetto. New York: Appleton-Century-Crofts, 1969, 133-152.

63. Lepper, M. H., Lashof, J. C., Lerner, M., German, J., and Andelman, S. L.: Approaches to meeting health needs of large poverty populations. American Journal of Public Health, 57: 1153-1157, 1967.

64. Garfield, S. R.: The delivery of medical care. Scientific Americans, 222: 15-23, 1970.

65. Schonfeld, H. K., Heston, J. F., and Falk, I.S.: Numbers of physicians required for primary medical care. New England Journal of Medicine, 286: 571-576, 1972.

66. Blumberg, M. S. Trends and Projections of Physicians in the United States 1967-2002. Berkeley: Carnegie Commission on Higher Education, 1971.

67. Schwartz, W. B.: Policy analysis and the health care system. Science, September 15, 1972, 967-969.

68. Levy, L.: Factors which facilitate or impede transfer of medical functions from physicians to paramedical personnel. Journal of Health and Human Behavior, 7: 50-54, 1966.

69. American Medical Association. "Expanding the Supply of Health Services in the 1970's." American Medical Association, Chicago, Illinois, 1970.

70. Editorial. Ruminitions: A lesson from Gus. Journal of the American Medical Association, 227: 935-936, 1974.

71. Briefings: New models for delivery of service. Health Services Research, 6: 263-264, 1971

72. Sidel, V. W.: Can more physicians be attracted to ghetto practice? In Norman, J. C. (Ed.). Medicine in the Ghetto. New York: Appleton-Century-Crofts, 1969, 171-180.

73. Kavaler, F.: People, providers and payment - Telling it how it is. American Journal of Public Health, 59: 825-829, 1969.

74. Looff, D. H.: Rural Appalachians and their attitudes toward health. In Nolan, R. L. and Schwartz, J. L. (Eds.) Rural and Appalachian Health. Springfield, Illinois: Charles C. Thomas, 1973, 3-29.

75. Parker, R. C., Rix, R. A. and, Tuxill, T. G.: Social, economic, and demographic factors affecting physician populations in upstate New York. New York State Journal of Medicine, 69: 706-712, 1969.

76. MacQueen, J. C.: A study of Iowa medical physicians. Journal of the Iowa Medical Society, 58: 1129-1135, 1968.

77. Oseasohn, R., Mortimer, E. A., Geil, C. C., Eberle, B. J., Pressman, A. E., and Quenk, N. L.: Rural medical care: Physician's assistant linked to an urban medical center. Journal of the American Medical Association, 218: 1417-1419, 1971.

78. American Medical Association: "Increasing Availability of Health Services in Rural Areas: A Progress Report." American Medical Association, Chicago, Illinois, June, 1973.

79. Doyle, D. B.: Are medical schools preparing physicians for the ghetto? In Norman, J. E. (Ed.), Medicine in the Ghetto. New York: Appleton-Century-Crofts, 1969, 191-195.

80. Marshall, C. L. and Wallerstein, E. "To Establish a Bi-Directional Video Communication Link Between a Housing Project Clinic and the Mount Sinai Medical Center." Final report of contract HSM 110- 72-382, Bureau of Health Services Research, U.S. Public Health Service, Department of HEW, July, 1973.

81. "Physician Support Personnel, 1973-1974." DHEW Publication No. (NIH) 74-318, prepared by the American Medical Association and the Department of Health, Education, and Welfare, Washington, D.C., 1974.

82. Todd, M. C.: National certification of physician's assistants by uniform exams. Journal of the American Medical Association, 222: 563-566, 1972.

83. Bird, K. T. "Conclusions from Experiences with Telemedicine." Report presented at the Second Arizona Conference on Rural Health, Tucson, Arizona, April 30, 1973.

84. Borsay, M.: Some factors involved in the acceptance and rejection of the family nurse. Frontier Nurses Service Quarterly Bulletin, 46: 3-13, 1970.

85. Schorr, L. B.: The neighborhood health center - background and current issues. In Corey, L., Saltman, S. E., and Epstein, M. F. (Eds.), Medicine in a Changing Society. St. Louis: C. V. Mosby Company, 1972, 138-147.

86. Isaacs, G.: The family nurse and primary health care in rural areas. In Nolan, R. L. and Schwartz, J. L. (Eds.), Rural and Appalachian Health. Springfield, Illinois: Charles C. Thomas, 1973, 117-125.

87. A 'super-nurse' acts as a doctor substitute. Medical World News, November 23, 1973, 63.

88. Michaelson, M.: Will your next doctor be a doctor? Today's Health, 48: 37-41, 84-85, 1970.

89. National Commission on Community Health Services. Health is a Community Affair. Cambridge, Massachusetts: Harvard University Press, 1966.

90. Todd, M. C. and Foy, D. F.: Current status of the physician's assistant and related issues. Journal of the American Medical Association, 220: 1714-1720, 1972.

91. Yerby, A. S.: Health care systems-Some international comparisons. Technology Review, 72: 25-27, 1970.

92. Zweifler, A. J. and Corey, L.: Physician manpower and the health care team. In Corey, L., Saltman, S. E., and Epstein, M. F. (Eds.), *Medicine in a Changing Society*. St. Louis: C. V. Mosby Company, 1972, 117-127.

93. Sidel, V. W. and Sidel, R.: The delivery of medical care in China. *Scientific Americans*, 230: 19-27, 1974.

94. Hughes, J. M.: Ghana - paramedical personnel at VALCO. In Hughes, J. P. (Ed.), *Health Care for Remote Areas*. Oakland, California: Kaiser Foundation International, 1972, 80-83.

95. Jensen, R. T.: The primary medical care worker in developing countries. *Medical Care*, 5, 6: 382-400, 1967.

96. Drobny, A.: Relating Pan-American experience to the solution of rural health problems in the United States. In Nolan, R. L. and Schwartz, J. L. (Eds.), *Rural and Appalachian Health*. Springfield, Illinois: Charles C. Thomas, 1973, 96-109.

97. Hyman, H. H. (Ed.). *The Politics of Health Care: Nine Case Studies of Innovative Planning in New York City*. New York: Praeger Publishers, 1973.

98. Milt, H. M. (Ed.). "1970 National Health Forum: Meeting the Crisis in Health Care Services in our Communities." National Health Council, New York, N. Y., 1970.

99. Neighborhood Health Centers. *Health/PAC Bulletin*, June, 1972.

100. Wilson, R. N. *The Sociology of Medicine*. New York: Random House, 1970.

101. Murphy, R. L. H. and Bird, K. T.: Telediagnosis: A new community health resource: Observations on the feasibility of telediagnosis based on 1,000 patient transactions. *American Journal of Public Health*, 64: 113-119, 1974.

102. Eberle, B. J., Benham, L. B., Chatkoff, M. L., Geil, C. C., Mortimer, E. A., Obenshain, S. S., Oseasohn, R., Pressman, A. E., and Quenk, N. L.: Evaluation of a rural health service employing a physician's assistant. Report of the Department of Epidemiology and Community Medicine, and Department of Pediatrics, University of New Mexico School of Medicine, Albuquerque, New Mexico, no date.

103. Kaku, K., Gilbert, F. I. and Sachs, R. R.: Comparison of health appraisals by nurses and physicians. *Public Health Reports*, 85: 1042-1046, 1970.

104. Duncan, B., Smith, Ann, and Silver, H. K.: Comparison of the physical assessment of children by pediatric nurse practitioners and pediatricians. *American Journal of Public Health*, 61: 1170-1176, 1971.

105. Stein, L.: The doctor-nurse game. Archives Of General Psychiatry, 16: 699-703, 1967.

106. Freidson, E.: Professionalism: The doctor's dilemma. Social Policy, January-February, 1971, 35-40.

107. Nursing education: Teaching the woman to know her place. Health/PAC Bulletin, September, 1970, 7-11.

108. Bennett, I. L.: Conditions and problems of technological innovation in medicine. Technology Review 72: 42-48, 1970.

109. Smith, J. W. and O'Donovan, J. B.: The practice nurse - A new look. British Medical Journal, 4: 673-677, 1970.

110. Hagedorn, H. J. and Dunlop, J. J.: Health care delivery as a social system: Inhibitions and constraints on change. Proceedings of the IEEE, 57: 1894-1900, 1969.

111. Ross, S. A.: The clinical nurse practitioner in ambulatory care service. Bulletin of the New York Academy of Medicine, 49: 393-402, 1973.

112. Patterson, P. K., Bergman, A. B., and Wedgwood, R. J.: Parent reaction to the concept of pediatric assistants. Pediatrics, 44: 69-75, 1969.

113. Lewis, C. E. and Resnik, B. A.: Nurse clinics and progressive ambulatory patient care. New England Journal of Medicine, 277: 1236-1241, 1967.

114. Lees, R. E. M. and Anderson, R. M. A.: Patient attitudes to the expanded role of the nurse in family practice. Canadian Medical Association Journal, 105: 1164-1168, 1971.

115. Norman, J. C. (Ed.): Discussion. In Norman, J. C. (Ed.), Medicine in the Ghetto. New York: Appleton-Century-Crofts, 1969, 267-268.

116. Conant, L., Robertson, L. S., Kosa, J., et al.: Anticipated patient acceptance of new nursing roles and physician's assistants. American Journal of Diseases of Children, 122: 202-205, 1971.

117. Steinman, G. D.: Health care barriers in Appalachia. In Nolan, R. L. and Schwartz, J. L. (Eds.), Rural and Appalachian Health. Springfield, Illinois: Charles C. Thomas, 1973, 56-64.

118. The nation's best ambulance service. Reader's Digest, 104: 95-98, 1974.

119. Lambrew, C. T., Schuchman, W. L., Cannon, T. H.: Emergency medical transport systems: Use of ECG telemetry. *Chest*, 63: 477-482, 1973.

120. Boyd, D. R., Dunea, M. M., Flashner, B. A.: The Illinois plan for a statewide system of trauma centers. *The Journal of Trauma*, 13:24-31, 1973.

121. Wright, I. S. and Frederickson, D. T.: Inter-relationships among health facilities - Future role of modern communications and transportation. *Circulation*, 43: 97-99, 1971.

122. Camden, J. W. *Emergency Medical Services*. Westport, Connecticut: Technomic, 1972.

123. Arnold, W. F.: U.S. seeks medical-emergency net. *Electronics*, 47: 81-84, 1974.

124. Chapman, W. E. (Ed.): Ventricular tracking pacemaker. *Postgraduate Medicine*, 53: 179-180, 1973.

125. Ryan, G. A. and Monroe, K. E. "Computer Assisted Medical Practice: the AMA's Role." Chicago: the American Medical Association, 1971.

126. McMahon, J.: Two-way radio keeps MD's abreast. *Health News* (New York State Department of Health), November, 1968, 2-7.

127. "V.E.T.E.R.A.N." Unpublished report, St. Louis Veterans Administration, St. Louis, Missouri, 1974.

128. Temps, J. P. and Soule, A. B.: Experiments with two-way television in a teaching hospital complex. *Journal of the American Medical Association*, 204: 1173-75, 1968.

129. Davis, R. M. "Communications for the Medical Community - A Prototype of a Special Interest Audience." Paper presented at AIAA 6th Annual Meeting and Technical Display, Anaheim, California, October 20-24, 1969.

130. Fortney, D. L.: Physicians phone for automatic medical advice. *Today's Health*, 48: 18-19, 1970.

131. "Tel-Med: Telephone Health Library for the Public." Pamphlet, Medical Society, County of Erie, N. Y., no date.

132. Davis, R. M. and Cummings, M. M. "The Promise of Communications for Medicine in the Seventies." Paper presented at the American Thoracic Society Annual Meeting, May 2, 1970.

133. Brown, L.: A 'Sesame Street' for adults on health care tests. *New York Times*, November 12, 1973, 1, 59.

134. Personal communication with Mr. Edward Wallerstein, Department of Community Medicine, Mt. Sinai School of Medicine, New York, New York, July 22, 1974.

135. Martino, J.: What computers may do tomorrow. *The Futurist*, October, 1969, 134-135.

136. Robinson, B.: "A Delphi Forecast of Technology in Education." M.A. Thesis, Program in Technology and Human Affairs, Report No. (R)T-73/1, Washington University, St. Louis, Missouri, August, 1973.

137. Caceres, C. A. (Chairman): Technology and modern health care for developing nations and the underprivileged. In *Engineering and Medicine*. Washington, D.C.: National Academy of Engineers, 1970, 133-160.

138. American Medical Association. "Statement on Multiphasic Health Screening." Unpublished report, American Medical Association, Chicago, Illinois, 1972.

139. "Projects Active in the Logistics Program as of June 30, 1973." Unpublished summary of projects, Health Care Technology Division, National Center for Health Services Research and Development, Health Resources Administration, Washington, D.C., June, 1973.

140. Pool, S. L. "Application of Space Technology to Remote Health Care." Unpublished, NASA, January, 1974.

141. Bird, K. T.: Interactive television: A new mode of education. *Educational Broadcasting Review*, 6: 441-442, 1972.

142. "Interact." Pamphlet by the Interactive Television Network, Dartmouth Medical School, Hanover, New Hampshire, no date.

143. Personal correspondence with E. H. Stansel, Deputy Director, Jacksonville Telemedicine Network, Jacksonville, Florida, July 10, 1974.

144. Telemedicine enters the era of troubled youth. *MGH News*, 30: 1-5, 1971.

145. Show me where it hurts. *St. Louis Post Dispatch*, May 5, 1974, (Parade) 5.

146. Schoolman, H. M.: Health communications in Alaska. *Journal of the American Medical Association*, 228: 1100, 1974.

147. Singh, J. P. and Morgan, R. P. "Identification of Fixed Broadcast Satellite-Based Educational and Health Telecommunications Services for the Appalachian Region." Center for Development Technology, Washington University, St. Louis, Missouri, June 1, 1972.

148. Dickson, E. M. and Bowers, R. "The Video Telephone, A New Era in Telecommunications: A Preliminary Technology Assessment." Program on Science, Technology, and Society, Cornell University, Ithaca, New York, June, 1973.

149. Goldhamer, H. C. and Westrum, R., (Eds.). "The Social Effects of Communication Technology." Rand Corporation Report R-486-RSF, Rand Corporation, Santa Monica, California, May, 1970.

150. On the Cable: The Television of Abundance. New York: Alfred Sloan Foundation, 1971.

151. National Academy of Engineering. Communications Technology for Urban Improvement. Washington D.C.: National Academy of Engineering, 1971.

152. Schensul, S. L. "An Addendum to an Evaluation Design - Picturephone Project." Unpublished report, Illinois Mental Health Institutes, Chicago, Illinois, no date.

153. "Communications Technology Satellite." Unpublished report, Communications Canada, Ottawa, Canada, November, 1973.

154. Personal correspondence with Kristen Roskoski, Project Analysis Coordinator, The University of Nebraska Medical Center, Omaha, Nebraska, May 21, 1974.

155. Murphy, R. L. H., Cohen, G. L., Herskovitz, J., and Bird, K. T. "Telediagnosis: A New Community Health Resource: Observations on the Feasibility of Tele-Diagnosis Based on 1,000 Patient Transactions." Unpublished report, Medical Service, Massachusetts General Hospital, Boston, Massachusetts, no date.

156. Wheelden, J. A. "Speech Therapy Via Interactive Television." Paper presented at the 1972 Annual Convention of the American Speech and Hearing Association, San Francisco, California, November 19, 1972.

157. Personal communication with Ms. Rosemary Bonanno of The Cambridge Hospital Project, Boston, Massachusetts, July 12, 1974.

158. Murphy, R. L. H., Haynes, H., Fitzpatrick, T. B., and Sheridan, T. B.: Accuracy of dermatologic diagnosis by television. Archives of Dermatology, 105: 833-835, 1972.

159. Oldham, R. C. and Folsom, J.: Doctor-patient communication system. Educational/Institutional Broadcasting, 2: 22-25, 1969.

160. Bruner, J. M. R.: The horrors of common practice. In Walter, C. W. (Ed.), Electric Hazards in Hospitals. Washington, D.C.: National Academy of Sciences, 1970, 119-129.

161. Myers, H. B.: The medical-industrial complex. Fortune, 81: 90-91, 92-99, 1970.

162. Ribicoff, A. The American Medical Machine. New York: Saturday Review Press, 1972.

163. Krause, E.: Health and the politics of technology. Inquiry, 8: 51-59, 1971.

164. "Your Health in Crisis." Health/PAC Special Report, Health Policy Advisory Center, New York, N.Y., May, 1972.

165. Mecklin, J. M.: Hospitals need management even more than money. Fortune, 81: 96-99, 150, 1970.

166. McNerney, W. J.: The role of technology in the development of health institution goals and programs. In Collen, M. F. (Ed.), "Technology and Health Care Systems in the 1980's." DHEW Pub (HSM)73-3016, National Center for Health Services Research and Development, Washington, D.C., 1972.

167. Grass, A. M.: The electronic industry's relationship to new instrumentation in biomedical research. In University of Nebraska College of Medicine: "Digest of Conference Proceedings: The Role of Biomedical Engineering in Universities and Hospitals," October 26-27, 1971.

168. "Ground Stations Will Aid Health Care, Education." Public Relations Department, Hughes Aircraft Co., Los Angeles, California, no date.

169. "Remote Health Care Systems Enters Manufacturing Stage." Newsbureau, Lockheed Missiles and Space Company, Inc., Sunnyvale, California, February 12, 1974.

170. Bird, K. T. "Telemedicine: Medicine of the Future Today." The Lowell Lectures in Medicine, Massachusetts Eye and Ear Infirmary, Boston, Massachusetts, March 27, 1973.

171. Munson, R. B.: New Mexico's proposed physician monitored remote area health program. Proceedings of IEEE, 57: 1887-1893, 1969.

172. Berger, M. M. (Ed.). Videotape Technique in Psychiatric Training and Treatment. New York: Brunner/Mazel, 1970.

173. Wittson, C. L. and Benschoter: Two-way television: Helping the medical center reach out. American Journal of Psychiatry, 129: 136-139, 1972.

174. Menolascino, F. J. and Osborne, R. G.: Psychiatric television consultation for the mentally retarded. American Journal of Psychiatry, 127: 157-162, 1970.

175. "Report from the Bedford VA Hospital Concerning Teleconsultation." Unpublished report, Bedford VA Hospital, Bedford, Massachusetts, May 20, 1971.

176. Andrus, W. S. and Bird, K. T. "Teleradiology: Remote Interpretation of Roentgenograms." Paper presented at Tutorial Seminar, Society of Photographic Scientists and Engineers, Newton, Massachusetts, July 21, 1972.

177. Murphy, R. L. H.: Microwave transmission of chest roentgenograms. American Review of Respiratory Diseases, 102: 771-777, 1970.

178. Andrus, W. S. and Bird, K. T.: Teleradiology: Evolution through bias to reality. Chest, 62: 655-657, 1972.

179. Murphy, R. L. H., Block, P., Bird, K. T., and Yurchak, P.: Accuracy of cardiac auscultation by microwave. Chest, 63: 578-581, 1973.

180. Health/PAC Bulletin No. 57, March/April, 1974, p. 15.

181. Reid, A. "New Directions in Telecommunications Research." Report to the Sloan Commission, New York, N. Y., June, 1971.

182. Weston, J. R. and Kristen, C. "Teleconferencing: A Comparison of Attitudes, Uncertainty, and Interpresonal Atmosphers in Mediated and Face-to-Face Group Interaction." Department of Communications, Ottawa, Canada, December, 1973.

183. Janofsky, A. I.: Affective self-discolsure in telephone versus face-to-face interviews. Journal of Human Psychology, 11: 93-103, 1971.

184. Short, J. A. "The Effects of Medium of Communication on Two Person Conflicts." Unpublished Doctoral Thesis, University of London, London, England, 1973.

185. Short, J. A. "Conflicts of Opinion and Medium of Communication." Unpublished working paper, Ref. E/72001/SH, Communications Studies Group, University College London, London, England, January, 1972.

186. Williams, E. "The Effects of Medium of Communication on Evaluation of a Conversation and the Converstaion Partner." Unpublished working paper, Ref. E/72131/WL, Communications Studies Group, University College London, London, England, 1972.

187. Ryan, P.: And the last word...on picturephones. New Scientist, 51: 401, 1971.

188. Somers, A. R.: The nation's health. Issues for the future. Annals of the American Academy of Political and Social Sciences, 399: 160-174, 1972.

189. Korsch, B. M. and Negrete, V. F.: Doctor-patient communication. Scientific American, 227: 66-74, 1972.

190. Freidson, E. Patients' Views of Medical Practice. New York: Russell Sage Foundation, 1961.

191. Freidson, E. Profession of Medicine. New York: Dodd, Mead, and Co., 1973.

192. Truax, C. B., Wargo, D. G., Frank, J. D., Imper, S. D., Battle, C. C., Hoehnsaric, R., Nash, E. H., and Stone, A. R.: Therapist empathy, genuineness, and warmth and patient therapeutic outcome. Journal of Consulting Psychology, 30: 395-401, 1966.

193. Newitt, J. B.: Health care in a changing culture: Looking toward the 1980's. In Collen, M. F., "Technology and Health Care Systems in the 1980's." DHEW Pub (HSM)73-3016, National Center for Health Services Research and Development, Washington, D.C., 1972.

194. Dittman, A. T. Interpersonal Messages of Emotion. New York: Springer Publishing Co., 1972.

195. Shulman, A. D.: A multichannel transactional model of social influence. In Nord, W. (Ed.), Concepts and Controversey in Organizational Behavior. Pacific Palisades, California: Goodyear Publishing Company, 1972, 386-295.

196. Duncan, S.: Nonverbal communication. Psychological Bulletin, 72: 118-137, 1969.

197. Shapiro, S. L.: On the vagueness of the olfactory sense. The Eye, Ear, Nose and Throat Monthly, 47: 572-576, 1968.

198. Schneider, R. A.: The sense of smell and human sexuality. Medical Aspects of Human Sexuality, 5: 156-168, 1971.

199. Cone, T. E.: Diagnosis and treatment: Some diseases, syndromes, and conditions associated with an unusual odor. Pediatrics, 41: 993-995, 1968.

200. Freeman, S. K.: Discussion paper: Odor and communication. Annals of the New York Academy of Sciences, 163: 406-412.

201. Odor of sanity. (Editorial) Journal of the American Medical Association, 212: 472-473, 1970.

202. Gellis, S. S.: Editor's note. In Gellis, S. S. (Ed.), The Year Book of Pediatrics 1967-68. Chicago: Year Book Medical Publishers, 1968.

203. Hall, E. T. The Hidden Dimension. Garden City, N. Y.: Anchor, Doubleday, and Co., 1966.

204. Argyle, M. The Psychology of Interpersonal Behavior. New York: Penguin Books, 1967.

205. Argyle, M. and Dean, J.: Eye-contact, distance, and affiliation. Sociometry, 28: 289-304, 1965.

206. Mehrabian, A.: Relationahip of attitude to seated posture, orientation, and distance. Journal of Personality and Social Psychology, 10: 26-30, 1968.

207. Exline, R. V.: Explorations in the process of person perception: Visual interaction in relation to competition, sex, and the need for affiliation. Journal of Personality, 31: 1-20, 1963.

208. Exline, R. V., Gray, D., and Schuette, D.: Visual behavior in a dyad as affected by interview content, and sex of respondent. Journal of Personality and Social Psychology, 1: 201-209, 1965.

209. Felipe, N. J. and Sommer, R.: Invasions of personal space. Social Problems, 14: 206-214, 1966.

210. Heilbronn, M. and Libby, W. L. "Comparative Effects of Technological and Social Immediacy Upon Performance and Perceptions During a Two-Person Game." Presented at the APA Convention, Montreal, Quebec, Canada, 1973.

211. Sommer, R: Studies in Space. Sociometry, 22: 247-260, 1959.

212. Kendon, A.: Some functions of gaze-direction in social interaction. Acta Psychologica, 26: 22-63, 1967.

213. Strongman, K.: Communicating with the eyes. Science Journal, March 1970, 47, 52.

214. Champness, B. G.: Mutual glance and the significance of the look. Advancement of Science, 26: 309-312, 1970.

215. Davies, M. F. "Cooperative Problem Solving." Unpublished working paper, Ref. E/71159/DV, Communications Studies Group, University College London, London, England, May, 1971.

216. Williams, E. "Brainstorming and Coalition Formation Over Telecommunications Media." Unpublished working paper, Ref. E/74003/WL, Communications Studies Group, University College London, London, England, January, 1974.

217. Milgram, S.: The experience of living in cities. Science, 167: 1461-1468, 1970.

218. Samora, J., Saunders, L., and Larson, R. F.: Medical vocabulary knowledge among hospital patients. Journal of Health and Human Behavior, 2: 83-92, 1961.

219. Saunders, L. Cultural Differences and Medical Care. New York: Russell Sage Foundation, 1954.

220. Munro, J. A.: Technology and modern health care. In Engineering and Medicine. Washington, D.C.: National Academy of Engineering, 1970, 148-150.

221. "Guidelines for Compensating Physicians for Services of Physician's Assistants." Board of Trustees Report Z, American Medical Association, House of Delegates, Chicago, Illinois, June, 1972.

222. Personal correspondence with Joseph E. Simonaitis, Assistant Director, Office of the General Counsel, American Medical Association, Chicago, Illinois, April 15, 1974.

223. Rosenbaum, M.: The issues of privacy and privileged communication. In Berger, M. M. (Ed.), Videotape Technique in Psychiatric Training and Treatment. New York: Brunner/Mazel, 1970, 198-206.

224. Lybrand, W. A. Reactor panel. In "Summary: Symposium on Distribution of Health Manpower." The American Medical Association, San Francisco, California, June 17, 1972.

225. Hofmann, P. B.: Meeting resistance to hospital automation. Hospital Progress, 52: 45-47, 60, 1971.

226. Collen, M. F. (Ed.). "Technology and Health Care Systems in The 1980's." DHEW Pub (HSM) 73-3016, National Center for Health Services Research and Development, Washington, D.C., 1972.

227. Ishiyama, T. and Grover, W. L.: The phenomenon of resistance to change in a large psychiatric institution. Psychiatric Quarterly Supplement, 34: 1-11, 1960.

228. Coleman, J. S., Katz, E., and Menzel, H. Medical Innovation: A Diffusion Study. Indianapolis: Bobbs-Merrill Co., 1966.

229. "Evaluation Plan for the Alaska Health Care Delivery Experiment." Unpublished report by the Institute for Communication Research, Stanford University, January 9, 1974.

230. Johansen, R. and Miller, R. H. "The Design of Social Research to Evaluate a New Medium of Communication." Unpublished working paper, Institute for the Future, Menlo Park, California, January, 1974.